

TABLE S2 | Character matrix for the phylogenetic analysis of the Gymnotiformes based on the data of Tagliacollo *et al.* (2016) and Peixoto *et al.* (2019) concatenated with the dorsolateral head muscles characters. “o&i” indicates polymorphic codification; and hyphen (-) indicates inapplicable state. Numbers after species name indicates specimens analyzed in Tagliacollo *et al.* (2016: tab. 1).

Adontosternarchus balaenops 182572

0001100100000110000000000001?10000001?01111100021?100000000010110001000110?0100001001100101110100000100100111111100?1111110011
100010000110111010110110001001000110101000110?110010110110111110010001000101001000100011?100011000100000100001111110102000001
001000111100110011000011100

Adontosternarchus clarkae 182580

0001100100000110000000000001110000001?01111100021?100000000010110001000110?0100001001100101110100000100100111111100?1111110011
100010000110111010110110001001000110101000110?110010110110111110010001000101001000100011?1000110????????????????????????????????
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Adontosternarchus devenanzii 19126

0001100100000110000000000001?10000001?01111100021?100000000010110001000110?0100001001100101110100000100100111111100?1111110011
100010000110111010110110001001000110101000110?110010110110111110010001000101001000100011?1000110????????????????????????????????
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Adontosternarchus nebulosus 14826

0001100100000110000000000001?10000001?01111100021?100000000010110001000110?0100001001100101110100000100100111111100?1111110011
100010000110111010110110001001000110101000110?110010110110111110010001000101001000100011?1000110????????????????????????????????
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Adontosternarchus sachsi 188863

0001100100000110000000000001?10000001?01111100021?100000000010110001000110?0100001001100101110100000100100111111100?1111110011
1000100001101110101101100010010001101010001100110010110110111110010002000100001000100011?100011000100000100001111110102000001
001000111100110011000011100

Akawaio penak

010101012?000110000000000001?10000??1?01?1?????????010000?00?0?????????????????????0?????????????????????0????????1111????????01000?11100000
100001???0?00???00100?0?????1100110?????1000?0?11020000??00?????????1?1?0101111000000??
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Apteronotus albifrons

16150000100102000011000010111000111000000001011100101100000001010111001000010001000000010001001001000001001001111111010
111111001110001000011101101011011000110100010010100011001100101101101111100010001000110001000000011?1000110010000010000011-
111010102000100111010102022011000011100

Apteronotus albifrons 36939

000100102000011000010111000111000000001011100101100000001010111001000010001000000010001001001000001001001111111010111
1110011100010000111011010110110001101000100101000110011001011011011110001000100011000100000001?1000110010000010000011-
111010102000100111010102022011000011100

Apteronotus albifrons 44716

000100102000011000010111000111000000001011100101100000001010111001000010001000000010001001001000001001001111111010111
1110011100010000111011010110110001101000100101000110011001011011011110001000100011000100000001?1000110010000010000011-
111010102000100111010102022011000011100

Apteronotus bonapartii 182585

000100102100011000010000001111110000000101110111110000000001011100100001000100000000001011??100000110?0011?1111??0???

11100111000100001110110101101100011010011001010001100110010110110111110010001000110001000000011?1000110010000010000311-0110101030001000110101020222011000011100

Apteronotus bonapartii 37171

00010010210001100001000000111110000000101110111100000000010111001000010001000000000001011?100000110?0011?1111???0???
11100111000100001110110101101100011010011001010001100110010110110111110010001000110001000000011?1000110010000010000311-0110101030001000110101020222011000011100

Apteronotus caudimaculosus 43246

0001001020000110000101110001?1000000000101110010110000000101011100100001000100000001000100100100000100100111111101?111
11100111000100001110110101101100011010001001010001100110010110110111100010001000110001000000011?1000110010000010000011-1110101020001001110101020222011000011100

Apteronotus cuchillejo

0001000020000110000101110001?100000000011110010101000000101011100100001100100000010001001001000001001?011111110?????1110011
10001000011101101011011000110100011?1011001100110010110110111100010001000110001000000011?100011????????????????????????????
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Apteronotus cuchillo

0001010020000110000101010101?100000000010111001010000000?101011100100001000100010001000100?????????1001?011111110?????1101?111
00010000111?????0?1????0?????????????01?00110011001011?110111100010000000110001?00000011?100011????????????????????????????
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Apteronotus ellisi 24040

0001001021000110000100000011111000000010111011?110000000001011100100001000100000000001011?100000110?0011?1111???????11100111
000100001110110101101100011010011001010001100110010110110111110010001000110001000000011?1000110????????????????????????????
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Apteronotus eschmeyeri

0001011020000110000101010001?100000000010111001010000001001010111001000010001000100010010010000010010011111110??1111110011
1000100001110110101101100011010001001010001100110010110110111100010000000110001000000011?1000110????????????????????????????
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Apteronotus leptorhynchus 190772

0001011020000110000101010001?10000000001011100101000000100101011100100001000100010001000100100100000100100111111101011111001
11000100001110110101101100011010001001010001100110010110110111100010000000110001000000011?10001100100000100000101000010102000
1102110101020222011000011100

Apteronotus magdalenensis

0001010020000110000101010101?10?000000010111001010000000?101011100100001000100010001000100?????????1001?011111110?????11010111
0001000011101??0?1????0?????????????01?00110?1100101?0?101111000100000?1?0001?00000011?100011????????????????????????????
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Apteronotus sp. 36837

0001001021000110000100000011?111000000010111011110000000001011100100001000100000000001011?100000110?0011?1111???????11100111
000100001110110101101100011010011001010001100110010110110111110010001000110001000000011?1000110????????????????????????????
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Archolaemus blax AF072163

0001000101000000000000000001?10000000101011100001000000001001010?00??00000011100000110000000001001000001?001111110?????1110001
??0000100?1011100010110001000000010011100011011111011000?111310001000100100000100001011110000110000010000100010001001001---
10000110100110103000111001

Brachyhypopomus beebei 39375

01010001000001100000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100000110011
110000010000111000100100000000100100001110111000001000100?11030000110000000000111101011110000000010010000000000110101000001
000000111020110111000011100

Brachyhypopomus brevirostris

010100010000011001000000000111000001?01?11000101?000000000101100100?10101010000100100100000001101110010011111111?00001110011
110000010000111000100100000000100100000110111000001000100?11030000110010000000011121111110000000010010000000000110102000001
000000111020110111000011100

Brachyhypopomus bullocki

010100010000011001000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100001110011
110000010000111000100100000000100100000110111000001000100?11030000110010000000011110111110000000?????????????????????????????
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Brachyhypopomus diazi GQ862642

010100010000011000000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100001110011
110000010000111000100100000000100100001110111000001000100?11030000110010000000011110101111000000?????????????????????????????
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Brachyhypopomus draco 16267

010100010000011000000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100000110011
110000010000111000100100000000100100001110111000001000100?110300001100000000001110111110000000010010000000000110101000001
000000111020110111000011100

Brachyhypopomus “longtail” 16705

010100010000011000000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100000110011
110000010000111000100100000000100100001110111000001000100?1103000011000000000011121111110000000?????????????????????????????
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Brachyhypopomus nsp. “PAL” GQ862643

010100010000011000000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100001110011
110000010000111000100100000000100100001110111000001000100?110300001100100000000111101011110000001?????????????????????????????
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Brachyhypopomus occidentalis 1849

010100010000011000000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100001110011
110000010000111000100100000000100100001110111000001000100?110300001100100000000111101011110000000?????????????????????????????
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Brachyhypopomus pinnicaudatus gi01

010100010000011000000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100000110011
110000010000111000100100000000100100001110111000001000100?1103000011000000000011121111110000000010010000000000110102000001
000000111020110111000011100

Brachyhypopomus sp. “roySullivan”

010100010000011000000000000111000001?01?1100001?000000000101100100?1010101000010010010000000110111001001111111100001110011
110000010000111000100100000000100100000110111000001000100?110300001100100000000111101011110000000?????????????????????????????
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Brachyhypopomus sp “PALEgi”

01010100010000011000000000000111000001?01?1100001?000000000101100100?10101010000100100100000001101110010011111111000011100
11110000010000111000100100000000100100001110111000001000100?110300001100100000000111101011110000001?????????????????????????????
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Brachyplatystoma juruense 39376

0001010121000110001000000001?12001001?01?11100001?0100000001111100100100100010000110100000000001001110010011111110?10001100111
111100010001111000100100000000000100101000110000001100000?112221001100100000000101021011110100000????????????????????????????????
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Gymnorhamphichthys hypostomus 18063

0001010121000110001000000001112001001?01?11100001?0100000001111100100100100010000110100000000001001110010011111110?10001100111
111101010001111000100100000000000100101000110000001100000?112221001100100000000101021011110100000????????????????????????????????
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Gymnorhamphichthys rondoni 179685

0001010121000110000000000001?12001001?01?11100001?0100000001111100100100100010000110100000000001001110010011111110?10001100111
111101010001111000100100000000000100101000110000001100000?11222100110010000000010102101111010000010001000000000110100010001--
02000101000111101000011100

Gymnorhamphichthys rondoni 179673

0001010121000110000000000001?12001001?01?11100001?0100000001111100100100100010000110100000000001001110010011111110?10001100111
111101010001111000100100000000000100101000110000001100000?11222100110010000000010102101111010000010001000000000110100010001--
02000101000111101000011100

Gymnorhamphichthys rosamariae 191142

0001010121000110000000000001112001001?01?11100001?0100000001111100100100100010000110100000000001001110010011111110?10001100111
1111100010001111000100100000000000100101000110000001100000?11222100110010000000010102101111010000010001000000000110100010001--
02000101000111101000011100

Gymnorhamphichthys rondoni 11515

0001010121000110000000000001?12001001?01?11100001?0100000001111100100100100010000110100000000001001110010011111110?10001100?11
111101010001111000100100000000000100101000110000001100000?11222100110010000000010102101111010000010001000000000110100010001--
02000101000111101000011100

Gymnotus arapaima GQ862647

0000000110110111200000000000?10001110200011000021000000010001000?011100110101001000010010001100000001001001111111??0??1110011
10000000101000101010?100000000110000000100110000000????0?11030100111200000001000?010011110000000????????????????????????????????
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Gymnotus ardilai 8175

0000000110110111200000000000?1000110020001100002100000000001000101110011010100100001001000000000001001001111111?00??1110011
1000000010100010101001000000001100000?100110000000????0?11030100111200000001000001001111000000????????????????????????????????
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Gymnotus bahianus 7245

0000000110110111200000000000?10001110200011000021000000000010001011100110101001000010010001100000001001001111111?000??1110011
10000000101000101010010000000011000000100110000000????0?11030100111200000001000001001111000000????????????????????????????????
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Gymnotus carapo 27325

00000001101101112000000000001000110&102000110000210000000100010001011100110101001000010010001100000001001001111111000??11100
11100000001010001010100100000000110000000100110000000????0?1103010011120000000100000100111100000010111000000000001110010011--
-0-000101030110011000011111

Gymnotus carapo 32294

00000001101101112000000000001000110&102000110000210000000100010001011100110101001000010010001100000001001001111111000??11100
11100000001010001010100100000000110000000100110000000????0?1103010011120000000100000100111100000010111000000000001110010011--
-0-000101030110011000011111

Gymnotus carapo 35859

00000001101101112000000000001000110&10200011000021000000010001000101110011010100100001001000110000000100100111111?000???1100
111000000010100010101001000000001100000001001100000000?????0?1103010011120000000100000100111000000010111000000000001110010011--
-0-000101030110011000011111

Gymnotus cataniapo GQ862655

010100011011011010000000000?1000111010001100002100000000001000101110011010100100001001000110000000100100111111?000???110011
100000000010001010100100000000010000001000110000000?????0?11030000111300001001000001001110000000?????????????????????????????
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Gymnotus cf. anguillaris NRL2009

010100011011011010000000000?1000110010001100002100000000001000101110011010100100001001000110000000100100111111?000???110011
100000000010001010100100000000010000001000110000000?????0?11030000111200001001000001001110000000?????????????????????????????
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Gymnotus chaviro 39364

010100011011011120000000000?1000110020001100002100000000001000101110011010100100001001000110000000100100111111?000???110011
1000000001010001010100100000000010000000000110000000?????0?11030100111200000001000001001110000000?????????????????????????????
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Gymnotus choco 8209

0000000110110111200000000000?10001100200011000021000000000010001011100110101001000010010000000000100100111111?000???110011
100000000101000101010010000000001100000001001100000000?????0?11030100111200000001000001001110000000?????????????????????????????
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Gymnotus coatesi GQ862657

010100011011011010000000000?1000111010001100002100000000001000101110011010100100001001000110000000100100111111?000???110011
100000000010001010100100000000010000001000110000000?????0?11020000111300001001000001001110000000?????????????????????????????
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Gymnotus coropinae 43746

01010001101101101000000000001000111010001100002100000000001000101110011010100100001001000110000000100100111111?000???110011
100000000010001010100100000000010000001000110000000?????0?1102000011120000100100000100111000000010111000000000001110010001--0-
000101030110011000011111

Gymnotus coropinae 7161

01010001101101101000000000001000111010001100002100000000001000101110011010100100001001000110000000100100111111?000???110011
100000000010001010100100000000010000001000110000000?????0?1102000011120000100100000100111000000010111000000000001110010001--0-
000101030110011000011111

Gymnotus curupira GQ862665

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100000000010001010100100000000010000000000110000000?????0?11030100111200000001000001001110000000?????????????????????????????
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Gymnotus cylindricus 1201

01010001101101100000000000001000110000001100002100000000001000101110011010100100001001000110000000100100111111?000???1100011
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000101030110011000011111

Gymnotus cylindricus GQ862667

01010001101101100000000000001000110000001100002100000000001000101110011010100100001001000110000000100100111111?000???1100011
100000000010001010100100000000010000000000110000000?????0?1102000011120000000100000100111000000110111000000000001110010001--0-
000101030110011000011111

Gymnotus henni 8231

Rhabdolichops caviceps

0001100110000010000000000011?11000000101011000101000000001001011000000000011100000110111000001001000001?00?11?11???0???1110011
1000001000101100001000000100000010011101011011111010010?112110010002011000001000010111100001100100010000100011000002000011
010000110120110103000111000

Rhabdolichops cf. stewarti 41406

0001100100000010000000000011?11000000101011000101000000001001011000000000011100000110111000001001000001?00?11?11???0???1110011
1000001000101111001000000100000010011101011011111010010?112110010002011000001000010111100001100100010000100011000002000011
010000110120110111000111000

Rhabdolichops cf. stewarti 49295

0001100100000010000000000011?11000000101011000101000000001001011000000000011100000110111000001001000001?00?11?11???0???1110011
1000001000101111001000000100000010011101011011111010010?112110010002011000001000010111100001100100010000100011000002000011
010000110120110111000111000

Rhabdolichops eastwardi

000110010000001000000000001111100000010101100010100000000100101100000000001110000011011100000100100000100011111110?0110111001
110000010001011000010000001000000010011101011011111010010?11211001000201100000100001011110000110010001000010001100000200001
1010000110120110111000111000

Rhabdolichops jegui 189017

0001100100000010000000000011?1100000010101100010?0000???????1011000000000011100000110111000001001000001?00?11?11???????11100111
0000010001011110010000001000000010011101011011111010010?1121100100020110000010000101111000011????????????????????????????????
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Rhamphichthys apurensis 43111

0001010121000110010000000001?11001101?01?11000001?000000100111110010000010001000010010000000001001110010011111110?10001110111
11110001000011100010010000000100010110000011000000?112401001100100000001101021011110100000????????????????????????????????
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Rhamphichthys apurensis T9915

0001010121000110010000000001?11001101?01?11000001?000000100111110010000010001000010010000000001001110010011111110?10001110111
11110001000011100010010000000100010110000011000000?112401001100100000001101021011110100000????????????????????????????????
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Rhamphichthys drepanium

0001010121000110010000000001111001101?01?11000001?000000100111110010000010001000010010000000001001110010011111110?10001110111
11110001000011100010010000000100010110000011000000?11240100110010000000110102101111010000011001000000000110101010011--
01000111020111101100011000

Rhamphichthys hahni 19226

0001010121000110010000000001?11001101?01?11000001?000000100111110010000010001000010010000000001001110010011111110?10001110111
11110001000011100010010000000100010110000011000000?11240100110010000000110102101111010000011001000000000110101010011--
01000111020111101100011000

Rhamphichthys lineatus 116566

0001010121000110000000000001?11001101?01?11000001?000000100111110010000010001000010010000000001001110010011111110?10001110111
11110001000011100010010000000100010110000011000000?112401001100100000001101021011110100000????????????????????????????????
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Rhamphichthys marmoratus 42545

0001010121000110010000000001?11001101?01?11000001?000000100111110010000010001000010010000000001001110010011111110?10001110111
11110001000011100010010000000100010110000011000000?11240100110010000000110102101111010000011001000000000110101010011--
01000111020111101100011000

Sternarchogiton nattereri 182208

0001100120000110000100000011?12100000001111011110100000000101110010000101010000100110010110110000011010011111110?0???1110011
10001000011101101011011000100100011000100111001100101100&110111111010002000110001000000011?1000110????????????????????????????
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Sternarchogiton nattereri 37136

0001100120000110000100000011?12100000001111011110100000000101110010000101010000100110010110110000011010011111110?0???1110011
10001000011101101011011000100100011000100111001100101100&110111111010002000110001000000011?1000110????????????????????????????
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Sternarchogiton porcinum 182212

0001100120000110000100000011?121000000011110111101000000???10111001000010101000010011001011011000001101?01????1????
??1?????????0?0?1????0????0????0????0????0????1???110?110010????1011111110?00020001?00100000011?1000110010000010000211-
0110101010001001110101120222111000011100

Tenebrosternarchus preto 57528

0001100120000110000100000011121000000011110111101000000???10111001000010101000010011001011011000001101?01????1????
??1?????????0?0?1????0????0????0????0????0????1???110?110010????1011111110?00020001?00100000011?1000110010000010000211-
0110101010001001110101120222111000011100

Sternarchogiton sp. 28120

0001100120000110000100000011?121000000011110111101000000???10111001000010101000010011001011011000001101?01????1????
????0????1????0????0????0????0????0????0????1???110?110010????1011111110?00020001?00100000011?1000110010000010000211-
????????????????

Sternarchorhamphus muelleri 182579

00010101210001100000000000111100000001011101001100000000011100001000101010100000100010111010000010010111111110?01111101?1
111001000011101101011011000001000100100000110011001011011112331110001000011001000100011?100011101000000000011-11101020201--
00000101020111002000011100

Sternarchorhynchus cf. galibi 35866

0001010101?00110000000010001?100????0001111?0?0????1?????1111??0?01????1?????11?????????0?
0????????0????0????0????0????0110??1?10????10112211????0?????1?00100011?100011??
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Sternarchorhynchus galibi 187155

0001010101?00110000000010001?100????0001111????0?????1?????1111??0?01????1?????11?????????0?
0????????0????0????0????0????0110??1?10????010112211????0?????1?00100011?100011??
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Sternarchorhynchus hagedornae 180637

0001010101000110000000010001110000000011110000100001000011110000100011?0100001000000101100000001001?011?1?11?????110??11
10010000111110101001100?0001000100101000110011001011001011221110100010001?001000100011?1000110????????????????????????????
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Sternarchorhynchus hagedornae 36892

000101010100011000000001000111000000001111000010000100001111000010001100100001000000101100000001001?011?1?11?????110??11
10010000111110101001100?0001000100101000110011001011001011221110100010001?001000100011?1000110????????????????????????????
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Sternarchorhynchus normyrus 182583

0001010101000110000000010001110000000011110000100001000011110000100011?01000010000001011000000010010011111110?0111101?11
11001?0001111101010011000000100010010?000110011001011001011231110100010001?0001000100011?100011????????????????????????????
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Sternarchorhynchus oxyrhynchus

0001010101000110000000010001?100000000011110000010000100000111110000100011?010000100000010110000000010010011111110?0111101?1
1110010000111111010100110000001000100101000110011001011001011231110100010001?0001000100011?100011001000000000011-01101110201--
0300010102022002000011100

Sternarchorhynchus sp. 36838

0001010101000110000000010001110000000001111?0001000010000011111000010001100100001000000101100?000001001?01????1??????11??????
????0?0??????0?????0??00????????????0110?1?10????10112211??????0??????1000100011?100011????????????????????????????????????
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Sternarchorhynchus sp. 37135

0001010101000110000000010001110000000001111?00010000100000111110000100011?0100001000000101100?000001001?01????1??????11??????
????0?0??????0?????0??00????????????0110?1?10????10112211??????0??????1000100011?100011????????????????????????????????????
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Sternarchorhynchus sp. 39556

0001010101000110000000010001110000000001111?00010000100000111110000100011?0100001000000101100?000001001?01????1??????11??????
????0?0??????0?????0??00????????????0110?1?10????10112211??????0??????1000100011?100011????????????????????????????????????
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Sternarchorhynchus sp. 4066

0001010101000110000000010001110000000001111?00010000100000111110000100011?0100001000000101100?000001001?01????1??????11??????
????0?0??????0?????0??00????????????0110?1?10????10112211??????0??????1000100011?100011????????????????????????????????????
???????????????

Sternarchorhynchus sp. 57516

0001010101000110000000010001110000000001111?00010000100000111110000100011?0100001000000101100?000001001?01????1??????11??????
????0?0??????0?????0??00????????????0110?1?10????10112211??????0??????1000100011?100011????????????????????????????????????
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Sternarchorhynchus sp. T533

0001010101000110000000010001110000000001111?00010000100000111110000100011?0100001000000101100?000001001?01????1??????11??????
????0?0??????0?????0??00????????????0110?1?10????10112211??????0??????1000100011?100011????????????????????????????????????
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Sternarchorhynchus starski 47080

0001010101000110000000010001110000000001111?00010000100000111110000100011?0100001000000101100?000001001?01????1??????11??????
????0?0??????0?????0??00????????????0110?1?10????10112211??????0??????1000100011?100011????????????????????????????????????
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Sternopygus astrabes

0001000100000000001020000000?100000001010111000010000000100101000001000000110000001000100000100100000100011111101?11011
1000110000010001011?000110100010000000100001000110111011010&100?11133000100000000000100001011101000011001000100001001-
010010100000101000011112011111000011100

Sternopygus dariensis 604059707

0000000101000000000?0000000?100????0101011100000000000010010100000?000?0011100000010?0100000100100000?001?1111??????1110?011
000?01?0??????0?????0??00????????0?1??11101110?011?1133000100?00000000100001011101000011????????????????????????????????
???????????????????

Sternopygus macrurus 39502

000000010100000000002000000011000000010101110000100000001001010000010000001100000010001000001001000001?0011111?????0??11
1000110000010001011?0001??100010000000100001001101110110110&100?11133000100100000000&10100001011101000011001000100001001-
010010100000101000011112011111000011100

Sternopygus macrurus 37350

0000000101000000000020000000?100000001010111000010000000010010100000100000011100000010001000001001000001?00111111?????1
11000110000010001011?001??100010000000100001001110111011011010&100?111330001001000000000100001011101000011001000100001001-
0100101000001010000111120111111000011100

Sternopygus xingu 19643

0000000101000000000020000000?100????01010111000010000000010010100000100000011100000010?0100000100100000?00111111?????
?1110?011000?01?0????????0?????0?00?????001??11101110?1011?0?11133000100100000000100001011101000011001000100001001-
0100101000001010000111120111111000011100

Tembeassu marauna

0001010021000110000100000001?100000?000101101?00?1100000?0010111001000?1010100000001000000?001000000?01???111111????????1100101
000100001120110001101100&1100&101101010001?00110?101100101112[12]1001??00000110??1000000011??01?????????????????????????
????????????????????????????????

Neotropical Ichthyology

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