Supplementary information for ‘Revision of *Undorosaurus*, a mysterious Late Jurassic ichthyosaur of the Boreal Realm’ by Nikolay G. Zverkov & Vladimir M. Efimov

Table S1. Selected measurements (mm) for *Undorosaurus gorodischensis* and *U. nessovi* (holotype and only specimen)

<table>
<tr><td>Quadrate</td><td colspan="5">U. gorodischensis
holotype UPM EP-II-20(572)</td><td>U. nessovi holotype II-24(785)</td></tr>
<tr><td>maximal length in ventral (condylar) region</td><td colspan="5">120</td><td>118</td></tr>
<tr><td>width in condylar region</td><td colspan="5">55</td><td>70</td></tr>
<tr><td>height</td><td colspan="5">150</td><td>155</td></tr>
<tr><td>width in region of quadrate foramen</td><td colspan="5">60</td><td>60</td></tr>
<tr><td>Basisphenoid</td><td colspan="5">U. gorodischensis UPM EP-II-20(572)</td><td>U. nessovi</td></tr>
<tr><td>length</td><td colspan="5">80</td><td>80</td></tr>
<tr><td>width</td><td colspan="5">134</td><td>138</td></tr>
<tr><td>height</td><td colspan="5">60</td><td>50</td></tr>
<tr><td>Stapes</td><td colspan="5">U. gorodischensis UPM EP-20(572)</td><td>U. nessovi</td></tr>
<tr><td>mediolateral length</td><td colspan="5">80</td><td>80</td></tr>
<tr><td>width of medial head</td><td colspan="5">40</td><td>53</td></tr>
<tr><td>height of medial head</td><td colspan="5">60</td><td>55</td></tr>
<tr><td>Articular</td><td colspan="5">UPM EP-20(572)</td><td>U. nessovi</td></tr>
<tr><td>длина</td><td colspan="5">82</td><td>80</td></tr>
<tr><td>height</td><td colspan="5">65</td><td>65</td></tr>
<tr><td>Scapula</td><td colspan="3">UPM EP-II-20(572)</td><td colspan="2">PMO 214.578</td><td>U. nessovi</td></tr>
<tr><td>Proximodistal length</td><td colspan="3">-</td><td colspan="2">240</td><td>225</td></tr>
<tr><td>width of proximal end</td><td colspan="3">100</td><td colspan="2">125</td><td>115</td></tr>
<tr><td>anteroposterior width of diaphysis</td><td colspan="3">50</td><td colspan="2">50</td><td>54</td></tr>
<tr><td>mediolateral thickness of diaphysis</td><td colspan="3">40</td><td colspan="2">35</td><td>25</td></tr>
<tr><td rowspan="2">Coracoid</td><td colspan="5">U. gorodischensis</td><td rowspan="2">U. nessovi</td></tr>
<tr><td colspan="3">UPM EP-II-20(572)</td><td colspan="2">PMO 214.578</td></tr>
<tr><td>anteroposterior length</td><td colspan="3">200</td><td colspan="2">225</td><td>-</td></tr>
<tr><td>mediolateral length</td><td colspan="3">165</td><td colspan="2">185</td><td>190</td></tr>
<tr><td>anteroposterior length of medial (intercoracoidal) facet</td><td colspan="3">140</td><td colspan="2">145</td><td>-</td></tr>
<tr><td>thickness of medial facet</td><td colspan="3">60</td><td colspan="2">?</td><td>-</td></tr>
<tr><td>length of glenoid contribution</td><td colspan="3">90</td><td colspan="2">95</td><td>100</td></tr>
<tr><td>length of scapular facet</td><td colspan="3">27</td><td colspan="2">40</td><td>25</td></tr>
<tr><td rowspan="2">Humerus</td><td colspan="5">U. gorodischensis</td><td rowspan="2">U. nessovi</td></tr>
<tr><td>UPM EP-20(572)</td><td>UPM EP-23(744)</td><td>UPM EP-II-20(1075)</td><td>UPM EP-II-27(870)</td><td>PMO 214.578</td></tr>
<tr><td>proximodistal length</td><td>152</td><td>173</td><td>160</td><td>160</td><td>150</td><td>183</td></tr>
<tr><td>anteroposterior width proximal end</td><td>100</td><td>110</td><td>103</td><td>125</td><td>120</td><td>107</td></tr>
<tr><td>thickness of proximal end (measured perpendicular to ventral surface)</td><td>65</td><td>70</td><td>70</td><td>70</td><td>67</td><td>90</td></tr>
</table>

anteroposterior width of distal end (fU/fR/faae)	98 (50/55/-)	110 (50/57/20)	110 (50/60/20)	110(50/57/ 20)	115 (55/50/20)	135 (60/65/20)
dorsoventral width of distal end (fU/fR/faae)	-	56 (50/56/35)	60 (50/60/33)	60 (53/60/25)	63 (57/63/35)	64 (55/64/30)
width at diaphysis	75	80	70	74	73	77
Femur *U. gorodischensis*	**UPM EP-II-20(572)**				**PMO 214.578**	
proximodistal length	110				112	
width of proximal end	55				58	
width of distal end	75				83	

Table S2. Basisphenoid proportions in ophthalmosaurids

Taxon (specimen)	Maximal width of basisph.	Maximal length of basisph.	Width to length ratio	Source
U. gorodischensis **(UPM EP-II-20(572))**	**134**	**80**	**1,675**	Herein. NGZ pers. obs.
U. nessovi **(UPM EP-II-24(785))**	**138**	**80**	**1725**	Herein. NGZ pers. obs.
Grendelius mordax (SMC J68516)	115	76	**1.513**	McGowan, 1976
G. alekseevi (YKM 56702)	**131**	**89**	**1,472**	NGZ pers. obs.
G. pseudoscythicus (UPM 3/100)	**105**	**65**	**1,615**	NGZ pers. obs.
Arthropterygius chrisorum (CMN 40608)	**98**	**78**	**1.256**	Maxwell 2010
Ophthalmosaurus icenicus (NHMUK R. 2149)	**105**	**72**	**1.458**	Andrews 1910
O.icenicus (NHMUK R. 2162)	**119**	**75**	**1.587**	
O.icenicus (NHMUK R. 2740)	**110**	**87**	**1.264**	
O.icenicus (NHMUK R. 2161)	**92**	**64**	**1.438**	
O.icenicus (NHMUK R. 2155)	**98**	**76**	**1.289**	
Acamptonectes densus (GLAHM 132588)	est.130	95	1.368	Fischer *et al*. 2012
Platypterygius australis (AM F116940)	115	90	**1.278**	Kear 2005
P. platydactylus (type specimen destroyed)	**110**	**85**	**1.294**	Brioli 1907
Sisteronia seeylei (RGHP SI 2)	90	75	**1.200**	Fischer *et al*. 2014
Sveltonectes insolitus (IRSNB R269)	30	25	**1.200**	Fischer *et al*. 2011
Plutoniosaurus bedengensis (UPM 2/740)	**104**	**80**	**1.300**	NGZ pers. obs.

*measurements from the photographs are in regular font, direct measurements are in bold font.

Table S3. Measurements of ophthalmosaurids humeri (mm).

Taxon (specimen)	L / R	proximo-distal length	antero-posterior width proximal end	*thickness of proximal end	anteroposterior width of distal end	dorsoventral width of distal end	width at diaphysis	anteroposterior length		
								fU	fR	faae
***U. gorodischensis* UPM EP-20(572)**	L	152	100	65	98	55 *ca.*	75	50	55	05
***U. gorodischensis* UPM EP-23(744)**	R	173	110	70	110	56	80	50	57	20
***U. gorodischensis* UPM EP-II-20(1075)**	L	160	103	70	110	60	70	50	60	20
***U. gorodischensis* UPM EP-II-27(870)**	L	160	120	65	110	60	74	50	53	20
	R	160	125	70	110	60	74	50	57	17
***U. gorodischensis* PMO 214.578**	L	155	115	65	111	57	75	57	55	05
	R	150	120	67	115	63	73	55	50	20
***U. nessovi* (UPM EP-II-24(785))**	R	183	107	90	135	64	77	60	65	20
***U. trautscholdi* (SGM 1503)**	L	149	95	75	105	58	61	47	58	22
***U. kielanae* (GMUL UŁ no. 3579-81)**	R	118	75	65	83	41	50	50	50	NA?
***Ophthalmosaurus icenicus* (NHMUK R. 2134)**	L	170	130	90	145	55	80	48	63	34
***Arthropterygius chrisorum* (CMN 40608)**	L	220	172	100	195	95	140	70	80	65
***Janusaurus lundi* (PMO222.654)**	L	152	110	68	136	50	85	61	48	30
***Janusaurus lundi* (PMO222.654)**	R	155	105	60	130	50	85	60	50	30
***Grendelius alekseevi* (YKM 56702)**	L	154	104	55	106	40	85	40	47	NA
***G. zhuravlevi* (SRM Hb 30192)**	L	124	98	38	93	50	80	40	37	NA
***Plutoniosaurus bedengensis* (UPM 2/740)**	L	130	105	62	88	47	55	44	38	10
	R	125	107	54	90	45	55	43	40	10
***Platypterygius platydactylus* (Broili 1907)**	L	125	65	60 *ca.*	80	43	50 *ca.*	40	36	05

*More common is metric "dorsoventral width" of proximal end of the humerus, however, considering an existing torsion between the proximal and distal ends of the humerus precise identification of what is "dorsoventral width" became problematic especially in humeri with markedly anteroposteriorly elongated proximal ends and low angles of humeral torsion. By this reason, here we use another similar metric "thickness of proximal end" which could be defined as maximal height of the humeral proximal end measured perpendicular to the flat ventral surface of the humerus.

Data for this table were collected based on personal observations of NGZ and completed by measurements and in rare cases analysis of pictures of the following references: Broili 1907, Maxwell 2010, Moon & Kirton 2016, Tyborowski 2016.

Table S4. Ratios of ophthalmosaurids humeri.

Taxon (specimen)	L/R	proximodistal length/ anteroposterior width proximal end	proximodistal length/ anteroposterior width distal end	anteroposterior width proximal end/distalend	anteroposterior width proximal end/ thickness of proximal end	anteroposterior width of distal end/ dorsoventral width of distal end
***U. gorodischensis* UPM EP-20(572)**	L	1,520	1,551	1,020	1,538	1,782
***U. gorodischensis* UPM EP-23(744)**	R	1,573	1,573	1,000	1,571	1,964
***U. gorodischensis* UPM EP-II-20(1075)**	L	1,553	1,455	0,936	1,471	1,833
***U. gorodischensis* UPM EP-II-27(870)**	L	1,333	1,455	1,091	1,846	1,833
	R	1,280	1,455	1,136	1,786	1,833
***U. gorodischensis* PMO 214.578**	L	1,348	1,396	1,036	1,769	1,947
	R	1,250	1,304	1,043	1,791	1,825
***U. nessovi* (UPM EP-II-24(785))**	R	1,710	1,356	0,793	1,189	2,109
***U. trautscholdi* (SGM 1503)**	L	1,568	1,419	0,905	1,267	1,810
***U. kielanae* (GMUL UŁ no. 3579-81)**	R	1,573	1,422	0,904	1,154	2,024
***Ophthalmosaurus icenicus* (NHMUK R. 2134)**	L	1,308	1,172	0,897	1,444	2,636
***Arthropterygius chrisorum* (CMN 40608)**	L	1,279	1,128	0,882	1,720	2,053
***Janusaurus lundi* (PMO222.654)**	L	1,382	1,118	0,809	1,618	2,720
***Janusaurus lundi* (PMO222.654)**	R	1,476	1,192	0,808	1,750	2,600
***Grendelius alekseevi* (YKM 56702)**	L	1,481	1,453	0,981	1,891	2,650
***G. zhuravlevi* (SRM Hb 30192)**	L	1,265	1,333	1,054	2,579	1,860
***Plutoniosaurus bedengensis* (UPM 2/740)**	L	1,238	1,477	1,193	1,694	1,872
	R	1,168	1,389	1,189	1,981	2,000
***Platypterygius platydactylus* (Broili 1907)**	L	1,923	1,563	0,813	1,083	1,860

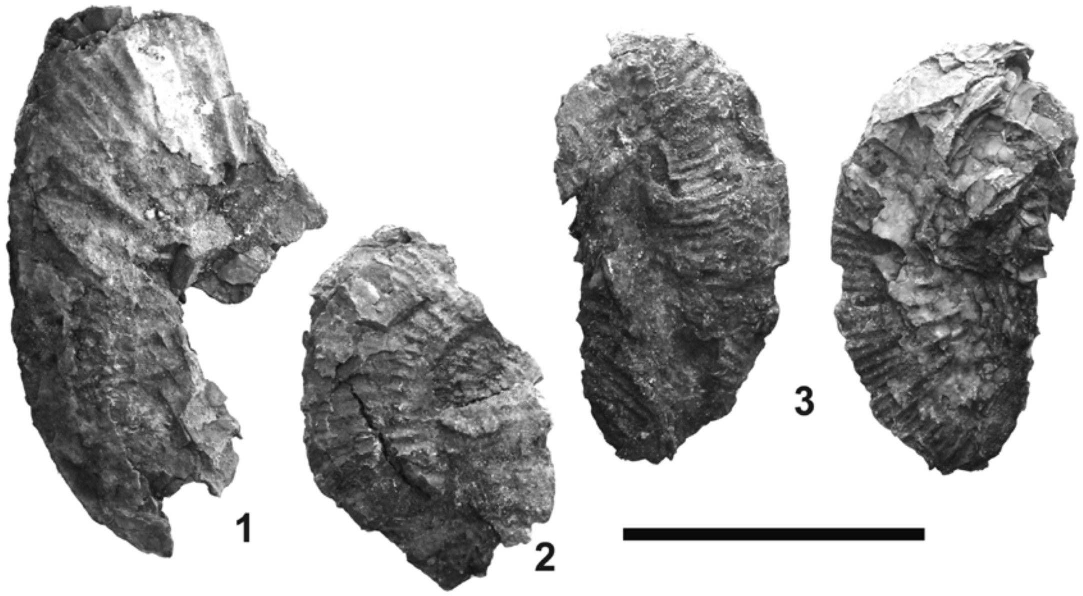


Figure S1. Ammonites *Taimyrosphinctes evolutus* Mesezhnikov, 1984 found in association with PMO 214.578. Identified by M.A. Rogov (Geological Institute of RAS). Scale bar represents 50 mm.

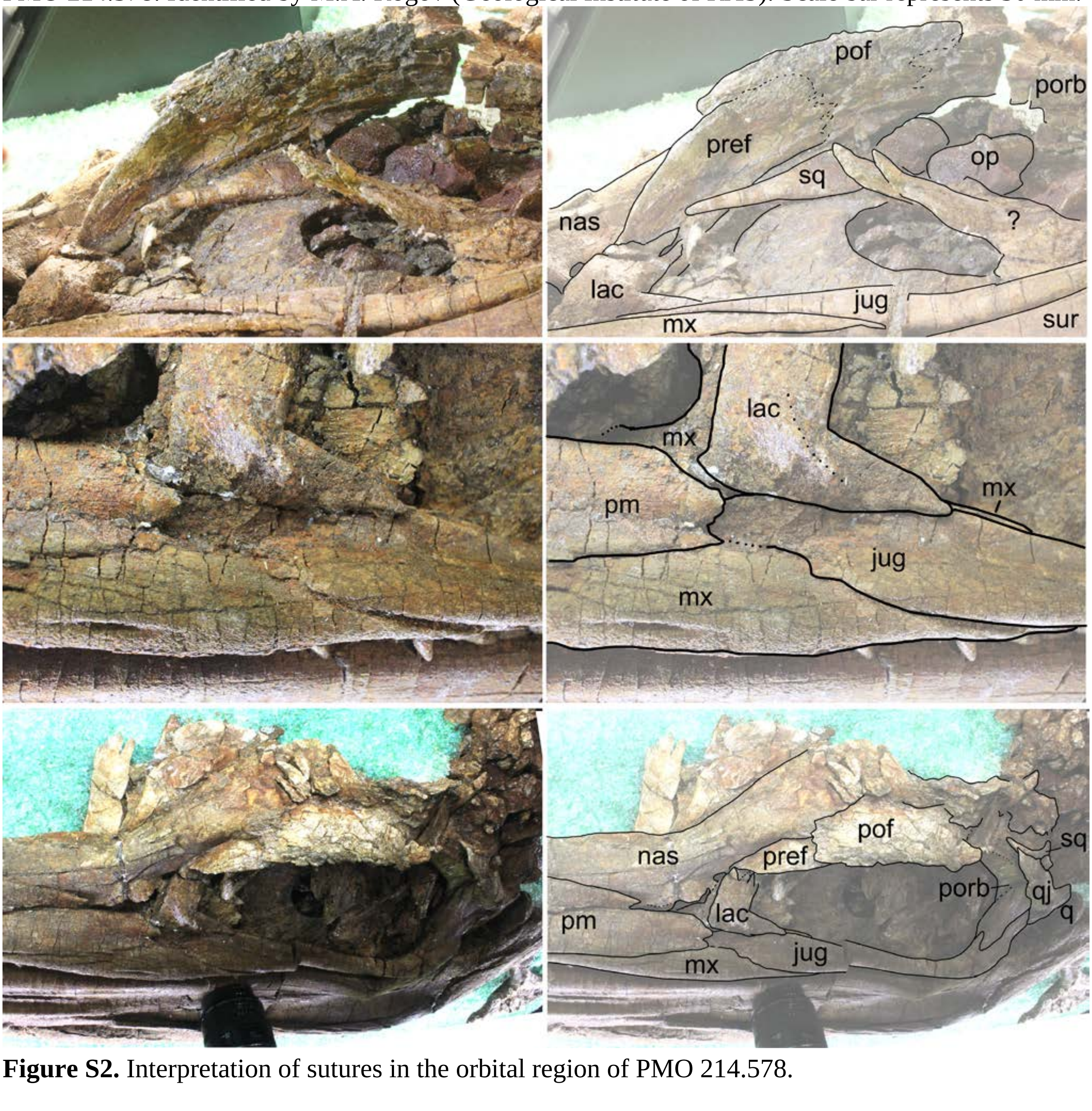


Figure S2. Interpretation of sutures in the orbital region of PMO 214.578.

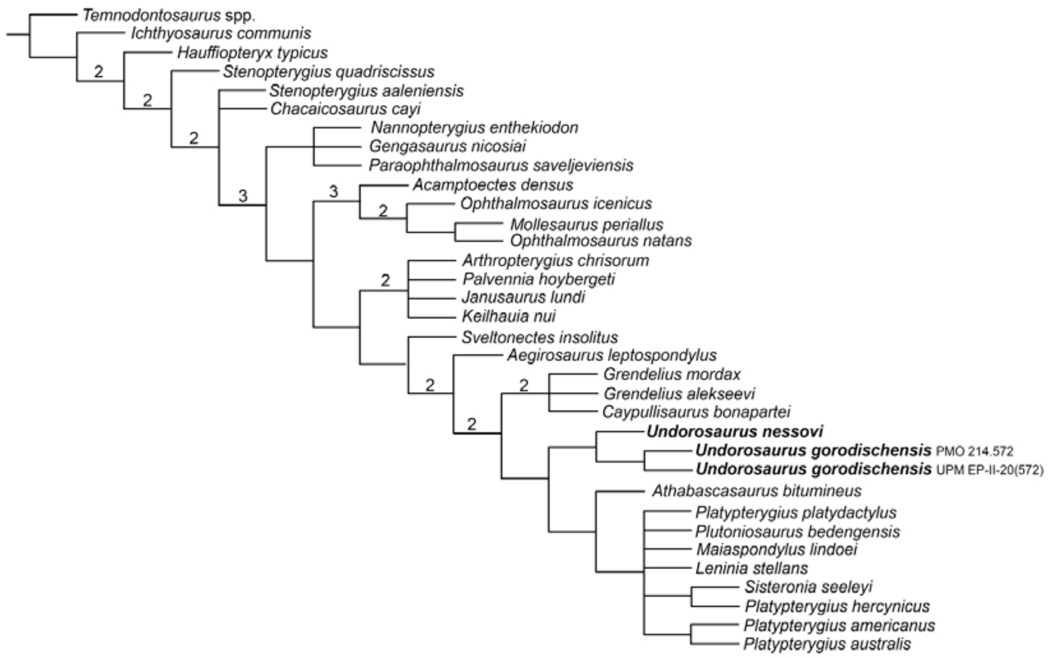


Figure S3. Result of additional phylogenetic analysis. Strict consensus of 6 most parsimonious trees. Bremer support values > 1 are shown above the branches.

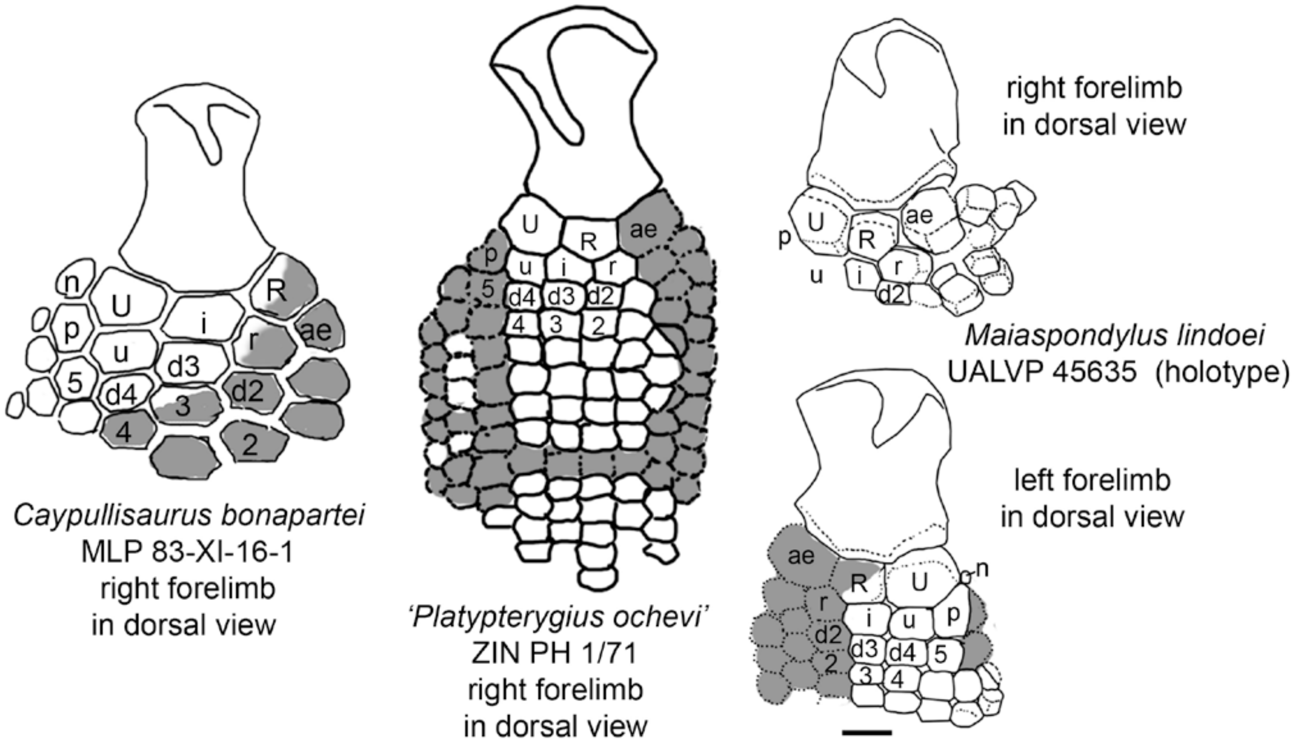


Figure S4. Interpretation of limb structure for *Caypullisaurus bonapartei* Fernández, 1997, '*Platypterygius* ochevi' Arkhangelsky *et al*., 2008 and *Maiaspondylus lindoei* Maxwell & Caldwell, 2006. Grey areas indicate missing and/or poorly preserved regions.

Modifications of character-taxon matrix

In addition of merging recent datasets (Fischer *et al.* 2012, 2014a, c, 2016; Roberts *et al.* 2014; Zverkov *et al.* 2015b; Maxwell *et al.* 2016; Paparella *et al.* 2017; Delsett *et al.* 2017) and adding four new OTUs (*Nannopterygius enthekiodon*, *Plutoniosaurus bedengensis, Undorosaurus nessovi*) we incorporated new morphological data for several other OTUs, based on first hand examination of their type materials (these are *Janusaurus lundi*, *Palvennia hoybergeti, Keilhauia nui* and *Paraophthalmosaurus saveljeviensis*). See List of OTUs below.

New characters were coded based on personal observations and literature (see OTU list below and references therein).

We also corrected a number of misinterpreted and miscoded character states (see comments regarding reinterpretations in the OTU list). Twenty-one new characters were added and nine characters were modified (see List of characters below).

OTU list
Modified from Fischer *et al.* 2016

Outgroup
1. *Temnodontosaurus* spp.
Stratigraphic range: Hettangian, Sinemurian; Toarcian.
Geographic range: Lyme Regis, Dorset and Whitby, Yorkshire, England; Banz, Bavaria and numerous localities in Baden-Württemberg, Germany; Arlon, Belgium; Yonne, Millau, and Belmont areas, France.
Data sources: Fraas 1913; McGowan 1974, 1979; Godefroit 1993; Maisch 2002; Maisch & Matzke 2000; Maisch & Hungerbühler 2001; Fischer et al. 2011a; Martin *et al.* 2012.
Specimen personally examined: None.
Principal reinterpretation: No.

Terminal taxa
2. *Ichthyosaurus communis* De la Beche & Conybeare, 1821
Stratigraphic range: 'Pre-Planorbis' beds, lowermost Hettangian–upper Sinemurian, Early Jurassic.
Geographic range: Dorset, UK; Lorraine, Belgium.
Data sources: de la Beche & Conibeare 1821; Sollas 1916; McGowan 1973; Godefroit 1996; Motani 2005; Maisch *et al.* 2008; Massare & Lomax 2017.
Specimen personally examined: None.
Principal reinterpretation: No.

3. *Hauffiopteryx typicus* Maisch, 2008
Stratigraphic range: Early Toarcian, Early Jurassic.
Geographic range: Holzmaden, Baden-Württemberg, Germany; Dudelange, Luxemburg; Ilminster, Somerset, UK.
Data sources: Godefroit 1994; Maisch 2008; Caine & Benton 2011; Marek *et al.* 2015.
Specimen personally examined: None.
Principal reinterpretation: No.

4. *Stenopterygius quadriscissus* (Quenstedt, 1856)
Stratigraphic range: Lower Toarcian; Lower Jurassic.
Geographic range: Holzmaden, Baden-Württemberg; Dobbertin, Germany; Dudelange, Luxembourg.
Data sources: Dechaseaux 1954; Johnson 1979; Godefroit 1994; Maisch 2008; Maxwell 2012
Specimen personally examined: MB R 4008, MB R 4012, Museum für Naturkunde, Berlin, Germany.
Principal reinterpretation: No.

5. *Stenopterygius/Chacaicosaurus cayi* Fernández, 1994
Stratigraphic range: *Emileia giebeli* Subzone, *E. multiformis* Zone of the Los Molles Formation, lower Bajocian, Middle Jurassic.
Geographic range: Chacaico Sur, Neuquén Basin, Argentina.
Data sources: Fernández, 1994
Specimen personally examined: None. Photographs of MOZ 5803 provided by V. Fischer (pers. comm. 2015).
Principal reinterpretation: No.

6. *Stenopterygius aaleniensis* Maxwell et al., 2012
Stratigraphic range: *Torulosum* Subzone, *Opalinum* Zone of the Opalinuston Formation, Lower Aalenian, Middle Jurassic.
Geographic range: Near Zell am Aichelberg, Baden-Württemberg, Germany.
Data sources: Maxwell *et al.* 2012
Specimen personally examined: None.
Principal reinterpretation: No.

7. *Ophthalmosaurus icenicus* Seeley, 1874
Stratigraphic range: Oxford Clay Formation (middle Callovian); Kimmeridge Clay Formation (*cymodoce* to *pectinatus* zones, lower Kimmeridgian–lower Tithonian), Upper Jurassic. Oxfordian to Kimmeridgian of Volga region.
Geographic range: Southeastern England, UK; possibly northern France; Volga region, European Russia.
Data sources: Seeley 1874; Andrews 1910a, b; Applebey 1956; Bardet *et al*. 1997; Maisch 1997, 1998; Araújo *et al*. 2008; Moon & Kirton 2016; Arkhangelsky *et al.* 2018.
Specimen personally examined: None in the UK, one specimen seen on display at the Museum of Evolution, Uppsala, Sweden; SRM OF 242/1-19, Syzran Museum of Local Lore, Sysran, Samara Region Russia.
Principal reinterpretation: No.

8. *Ophthalmosaurus natans* (Marsh, 1878)
Stratigraphic range: '*Sauranodon* beds' = Red Water shale Member, Sundance Formation, upper Callovian–middle Oxfordian, Middle–Upper Jurassic (Massare & Young 2005; Massare et al. 2006; Wahl 2009).
Geographic range: Numerous localities in Wyoming, USA (Massare et al. 2006).
Data sources: Marsh 1878; Gilmore 1902, 1906, 1907; Applebey 1956; Massare & Young 2005; Massare et al. 2006; Wahl 2009.
Specimen personally examined: None.
Principal reinterpretation: No.

9. *Mollesaurus perialus* Fernández, 1999
Stratigraphic range: *Emileia giebeli* Biozone of the Los Molles Formation, lower Bajocian, Middle Jurassic.
Geographic range: Chacaico Sur, Neuquén Basin, Argentina.
Data sources: Fernández 1999; Fernández & Talevi 2014
Specimen personally examined: None.
Principal reinterpretation: No.

10. *Acamptonectes densus* Fischer et al., 2012
Stratigraphic range: D2D horizon of the Speeton Clay Formation, basal Hauterivian; C7F–C7D horizons of the Speeton Clay Formation, lower–middle Hauterivian; *Simbirskites concinnus*/*staffi* Zone, upper Hauterivian, Lower Cretaceous.
Geographic range: Speeton and Filey, North Yorkshire, UK; Cremlingen, Lower Saxony, Germany.
Data sources: Fischer *et al.* 2012
Specimen personally examined: None.

Principal reinterpretation: No.

11. *Leninia stellans*
Stratigraphic range: *Deshayesites volgensis* Zone, Lower Aptian, Lower Cretaceous.
Geographic range: Kriushi, Sengiley district, Ulyanovsk Region, Russia.
Data sources: Fischer *et al*. 2014a
Specimen personally examined: YKM 65931.
Principal reinterpretation: No.

12. *Arthropterygius chrisorum* (Russell, 1993)
Stratigraphic range: Ringnes Formation, Oxfordian to Kimmeridgian, Upper Jurassic.
Geographic range: Cape Grassy, Melville Island, Northwest Territories, Canada.
Data sources: Maxwell 2010.
Specimen personally examined: None. Photographs of CMN 40608 provided by E. Maxwell (pers. comm. 2015).
Principal reinterpretation: basioccipital peg (Char. 42) should be coded as absent; forefin structure (Char. 89) 'latipinnate' not 'longipinnate'.

13. *Janusaurus lundi* Roberts et al., 2014
Stratigraphic range: Slottsmøya Member, Agardhfjellet Formation, lower to middle Volgian (Tithonian), Upper Jurassic.
Geographic range: Janusfjellet, Spitsbergen, Norway.
Data sources: Roberts *et al.* 2014
Specimen personally examined: holotype PMO 222.654.
Principal reinterpretation: several cranial features including the morphology of orbital, occipital and palatal regions (several characters for the jugal, basioccipital, basisphenoid, opisthotic and quadrate were scored and/or rescored).

14. *Palvennia hoybergeti* Druckenmiller et al., 2012
Stratigraphic range: *Dorsoplanites ilovaiskyi* to *Dorsoplanites maximus* zones, Slottsmøya Member, Agardhfjellet Formation, middle Volgian (Tithonian), Upper Jurassic.
Geographic range: north side of Janusfjellet, approximately 13 km northeast of Longyearbyen, Spitsbergen, Norway.
Data sources: Druckenmiller *et al*. 2012
Specimen personally examined: holotype, SVB 1451
Principal reinterpretation: a number of cranial features including the morphology of orbital and narial regions (e.g. presence of the squamosal and its shape), dental morphology; occipital and palatal regions (a number of characters for the basisphenoid, opisthotic and the quadrate). As for postcranial remains, scapular morphology and limb structure as well as additional data for humeral morphology were scored.

15. *Keilhauia nui* Delsett et al., 2017
Stratigraphic range: Slottsmøya Member, Agardhfjellet Formation, Janusfjellet Subgroup, early Berriasian, Early Cretaceous
Geographic range: North side of Janusfjellet, approximately 13 km north of Longyearbyen, Island of Spitsbergen, Svalbard, Norway.
Data sources: Delsett *et al*. 2017
Specimen personally examined: PMO 222.655 holotype and the only specimen
Principal reinterpretation: No, whereas a number of characters were additionally coded based on personal observations.

16. *Grendelius mordax* McGowan, 1976
Stratigraphic range: *Pectinates wheatleyensis* zone of the Kimmeridge Clay Formation, lower Volgian (lower Tithonian), Upper Jurassic.
Geographic range: Stowbridge, Norfolk; Kimmeridge Bay, Dorset, UK.

Data sources: McGowan 1976; McGowan 1997; Zverkov *et al.* 2015b
Specimen personally examined: None. High-resolution photographs of BRSMG Cc 16696 were provided by B.C. Moon (pers. comm. 2014) and high-resolution photographs of CAMSM J68516 were provided by V. Fischer (pers. comm. 2015).
Principal reinterpretation: following Zverkov *et al.* 2015 we recall that coding of *Brachypterygius extremus* and *Grendelius mordax* as a single OTU should be strongly prohibited.

17. *Grendelius alekseevi* (Arkhangelsky, 2001)
Stratigraphic range: *Dorsoplanites panderi* zone, middle Volgian (middle Tithonian), Upper Jurassic.
Geographic range: Detskiy sanatorium 18 km north of Ulyanovsk, right bank of the Volga River, Ulyanovsk District, Russia.
Data sources: Arkhangelsky, 2001; Zverkov *et al.* 2015b
Specimen personally examined: YKM 56702 holotype and the only specimen
Principal reinterpretation: No

18. *Caypullisaurus bonapartei* Fernández, 1997
Stratigraphic range: Numerous horizons within the Vaca Muerta Formation, lower Tithonian, Upper Jurassic to lower Berriasian, Lower Cretaceous.
Geographic range: Numerous localities in Neuquén Basin (Neuquén and Mendoza Provinces), Argentina.
Data sources: Fernández, 1997, 1998, 2001, 2007
Specimen personally examined: None. Photographs of MOZ 6139 provided by V. Fischer (pers. com. July 2015); photographs of MLP 83-XI-16-1 provided by M. Fernández (pers. com. 2014).
Principal reinterpretation: Forefin architecture see Fig. S4.

19. *Aegirosaurus leptospondylus* (Wagner, 1853)
Stratigraphic range: Solnhofen Formation, Malm Zeta 2b, lowermost Tithonian.
Geographic range: Solnhofen; Eichstätt, Bavaria, Germany.
Data sources: Wagner 1852; Meyer von 1863; Fraas 1891; Bardet & Fernández 2000; Scheyer & Moser 2011
Specimen personally examined: None.
Principal reinterpretation: No.

20. *Undorosaurus gorodischensis* Efimov, 1999b
Stratigraphic range: *Virgatites virgatus* to *Craspedites nodiger* zones of European Russia and *Crendonites anguinus* Zone of Svalbard, upper middle to upper Volgian (Tithonian), Upper Jurassic.
Geographic range: Moscow Province, Ulyanovsk Province, European Russia; Janusfjellet, Spitsbergen, Norway.
Data sources: Efimov 1999b; Druckenmiller *et al.* 2012
Specimen personally examined: UPM EP-II-20(572), holotype; UPM EP-II-23(744); UPM EP-II-21(1075); UPM EP-II-22(1073); UPM EP-II-27(870); YKM 44028-7; PMO 214.578
Principal reinterpretation: for PMO 214.578 postorbital and narial regions of the skull, forefin structure.

21. *Undorosaurus nessovi* Efimov, 1999*b*
Stratigraphic range: *Virgatites virgatus* zone, middle Volgian (middle Tithonian), Upper Jurassic.
Geographic range: Ulyanovsk Province, European Russia.
Data sources: Efimov 1999b
Specimen personally examined: holotype UPM EP-II-24(785)
Principal reinterpretation: No.

22. *Nannopterygius enthekiodon* (Hulke, 1871)
Stratigraphic range: *Aulacostephanus* sp. Biozones, Lower Kimmeridge Clay (Arkell 1933, p. 451), upper Kimmeridgian, Upper Jurassic.
Geographic range: Kimmeridge Bay, Dorset, UK.

Data sources: Hulke 1871; Huene,1922; Arkell, 1933; Kirton, 1983.
Specimen personally examined: None. Photographs of the hindlimb of holotype, BMNH 46497, provided by V. Fischer (pers. comm. July 2015).
Principal reinterpretation: hindlimb has three epipodial elements, anterior most is in contact with the femur.
Special note: the holotype is currently inaccessible, being mounted high to the ceiling and under the glass of showcase in the exhibition at NHMUK.

23. *Paraophthalmosaurus saveljeviensis* Arkhangelsky, 1997
Stratigraphic range: *Dorsoplanites panderi* to *Garniericeras catenulatum* Biozones, middle to upper Volgian (middle to upper Tithonian), Upper Jurassic.
Geographic range: Volga region, Ulyanovsk, Samara and Saratov provinces.
Data sources: Arkhangelsky 1997; Efimov 1999a
Specimen personally examined: SSU 104-23 holotype of '*Paraophthalmosaurus*' *saveljeviensis* Arkhangelsky, 1997; UPM EP-7(1235), holotype of '*Yasykovia yasykovi*' Efimov 1999a; UPM EP-9(1000).

24 *Gengasaurus nicosiai* Paparella et al., 2017
Stratigraphic range: Kimmeridgian to lowermost Tithonian; Calcari ad aptici e Saccocoma Formation, Upper Jurassic.
Geographic range: Camponocecchio, Genga, Ancona, Marche, Italy.
Data source: Paparella *et al*. 2017
Specimen personally examined: None.
Principal reinterpretation: Ulna was misidentified as the radius (Paparella *et al*. 2017: Fig. 6D).

25. *Athabascasaurus bitumineus* Druckenmiller & Maxwell, 2010
Stratigraphic range: Wabiskaw Member of the Clearwater Formation, lowermost Albian, Lower Cretaceous.
Geographic range: Syncrude Canada Ltd. base mine, near Mildred Lake, Alberta, Canada.
Data sources: Druckenmiller & Maxwell 2010; Maxwell & Druckenmiller 2011
Specimen personally examined: None.
Principal reinterpretation: No.

26. *Sveltonectes insolitus* Fischer et al., 2011
Stratigraphic range: ?Barremian, Lower Cretaceous. [The type specimen was found in the lower part of the Hauterivian layers (Upper Hauterivian) on the right bank of the Volga River, c. 12 km to the North of Ulyanovsk, near the Slantsevy Rudnik Village (V.M. Efimov pers. comm. February, 2016). By contrast dinocyst assemblage indicate the Barremian age of the specimen (Fischer *et al.* 2011), in this regard the age of the type specimen requires additional clarification].
Geographic range: Ulyanovsk area, Ulyanovsk region, Russia.
Data sources: Fischer *et al.* 2011*b*
Specimen personally examined: None.
Principal reinterpretation: No.

27. *Plutoniosaurus bedengensis* Efimov, 1997
Stratigraphic range: *Speetoniceras versicolor* Zone, Upper Hauterivian, Lower Cretaceous.
Geographic range: Right bank of the Volga River, 12 km upstream of the city of Ulyanovsk. Russia.
Data sources: Efimov 1997
Specimen personally examined: UPM 2/740.
Principal reinterpretation: No.

28. *Maiaspondylus lindoei* Maxwell & Caldwell, 2006
Stratigraphic range: Middle Albian, Lower Cretaceous.
Geographic range: A locality (60°01' N, 116°57' W) on the Hay River, Northwest Territories, Canada.

Data sources: Maxwell & Caldwell 2006
Specimen personally examined: None. Photographs of UALVP 45635 provided by E. Maxwell (pers. com. July 2016).
Principal reinterpretation: forefin structure, see Fig. S4.

29. *Platypterygius australis* (McCoy, 1867)
Stratigraphic range: Bulldog Shale, Aptian; Wallumbilla Formation, lower Aptian–upper Albian; Darwin Formation, late Aptian–Albian; Allaru Mudstone, middle–upper Albian; Toolebuc Formation, upper Albian; Alinga Formation, upper Albian–Cenomanian; Molecap Greensand, Cenomanian–Turonian, Lower–Upper Cretaceous Zammit (2010) and references therein. Kear (2003), however, considers *P. australis* to be restricted to the middle–upper Albian.
Geographic range: Numerous localities across Australia, see Kear (2003) for a review.
Data sources: M'Coy 1876; McGowan 1972; Wade 1984, 1990; Kear 2003; Kear 2005; Zammit 2010; Zammit *et al*. 2010
Specimen personally examined: None.
Principal reinterpretation: No.

30. *Platypterygius hercynicus* (Kuhn, 1946)
Stratigraphic range: Neocomer Erzhorizont, upper Aptian; lower *Callihoplites auritus* ammonite Subzone (*Mortoniceras inflatum* ammonite Zone), upper Albian, Lower Cretaceous.
Geographic range: Salzgitter, Lower Saxony, Germany; Saint-Jouin-Bruneval, Seine-Maritime, France.
Data sources: Kuhn 1946; Kolb & Sander 2009; Fischer 2012.
Specimen personally examined: None.
Principal reinterpretation: No.

31. *Platypterygius americanus* (Nace, 1939)
Stratigraphic range: Mowry Shale Member of the Graneros Formation, upper Albian; Ashville Formation, Albian-Cenomanian; Belle Fourche Shale; Lower Cenomanian, Lower–Upper Cretaceous.
Geographic range: Crook County, Wyoming; Southern Saskatchewan, Canada.
Data sources: Nace 1939, 1941; Romer 1968; Maxwell & Kear 2010.
Specimen personally examined: None.
Principal reinterpretation: No.

32. *Platypterygius platydactylus* Broili, 1907
Stratigraphic range: *Deshayesites deshayesi* Zone, Lower Aptian, Lower Cretaceous.
Geographic range: Castendamm, near Hannover, Lower Saxony, Germany.
Data sources: Broili 1907.
Specimen personally examined: None.
Principal reinterpretation: forefin structure sensu Fischer *et al.* 2016; anterior accessory facet of the humerus present.

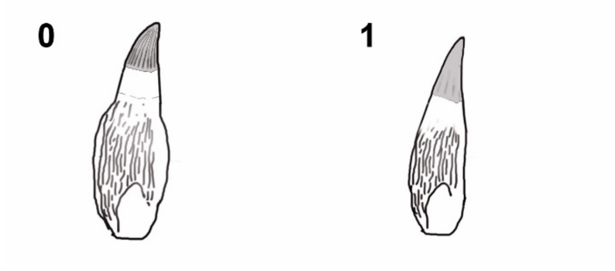
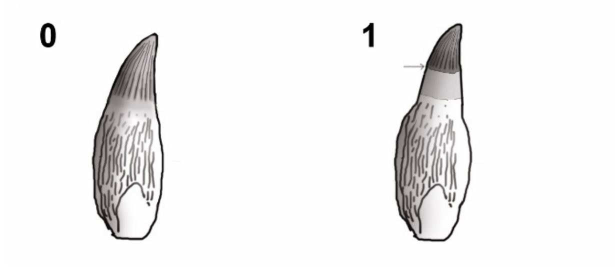
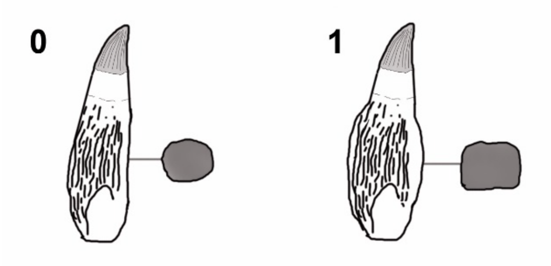
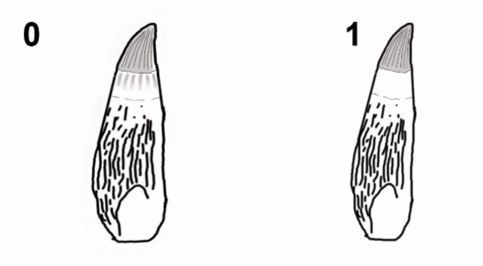
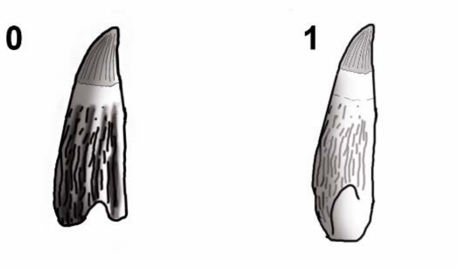
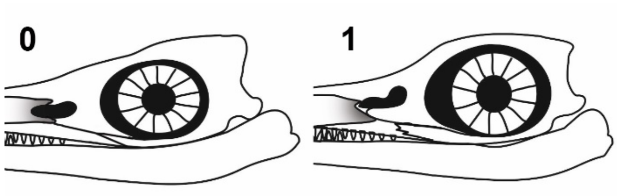
33. *Sisteronia seeleyi* Fischer et al., 2014
Stratigraphic range: Middle Albian–earliest Cenomanian.
Geographic range: Sisteron and Bevons, Vocontian Basin, France; Cambridgeshire, UK.
Data sources: Fischer *et al*. 2014b
Specimen personally examined: None.
Principal reinterpretation: No.

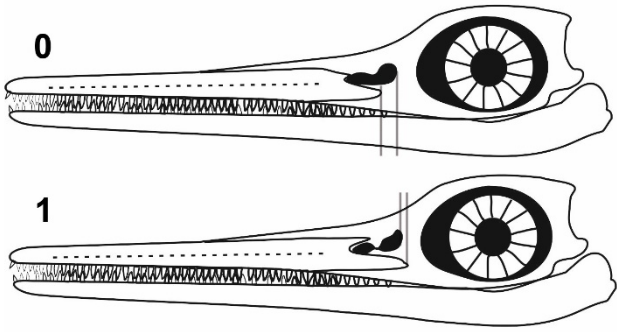
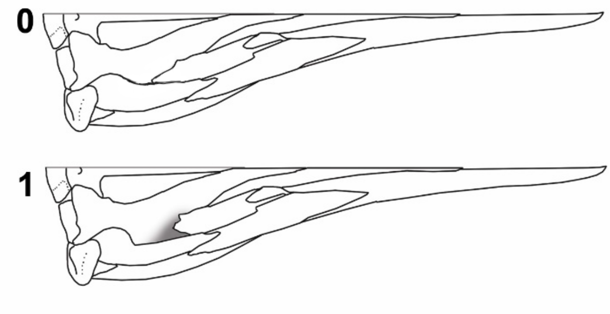
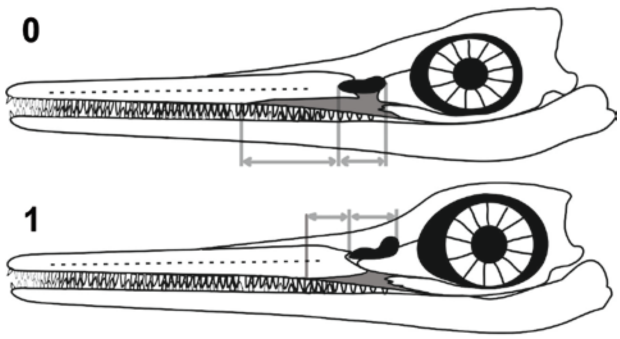
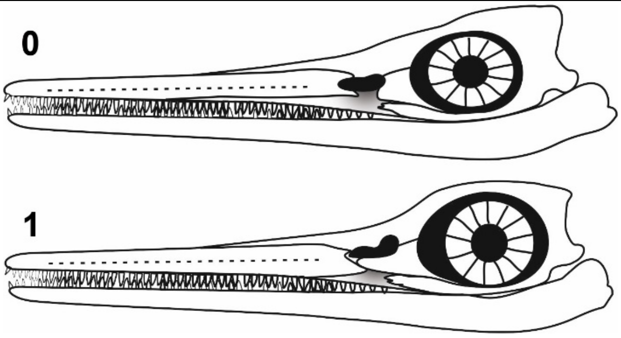
Table S4. Illustrated list of characters included in the phylogenetic analysis. All illustrations of character states are made by NGZ, the majority of them do not represent any specific taxa, some are redrawn from published literature.

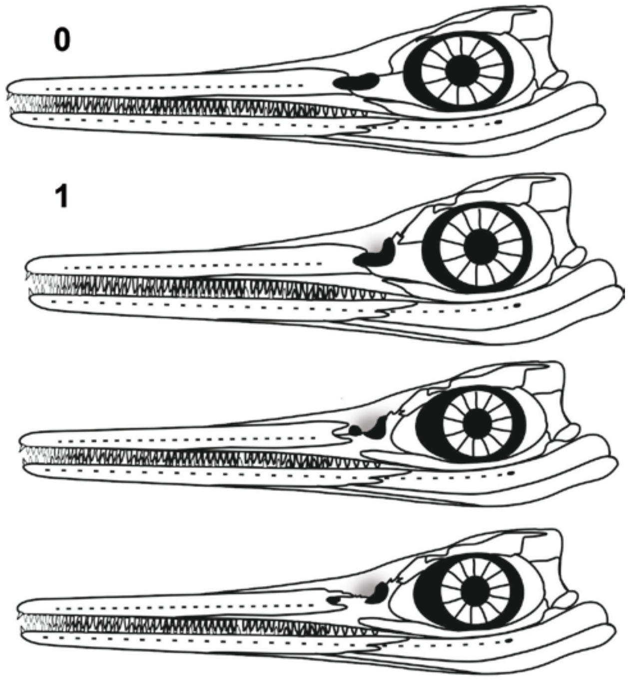
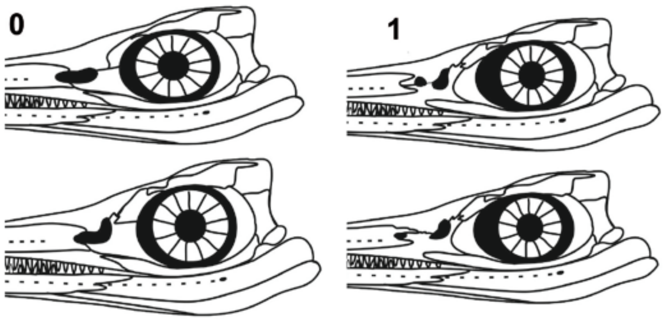
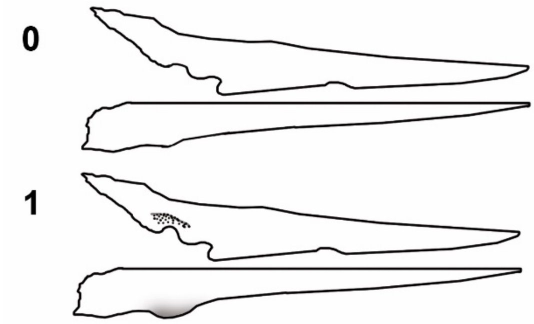
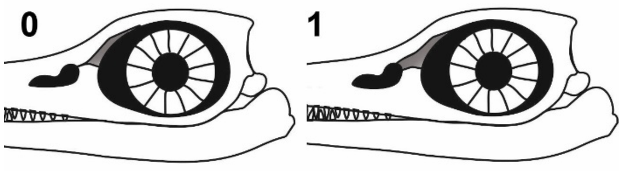
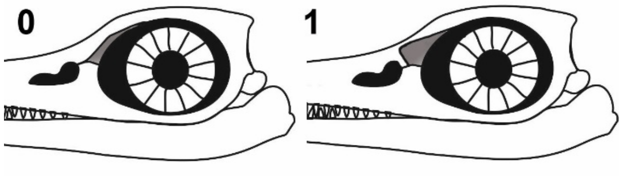
Table S4. Illustrated list of characters

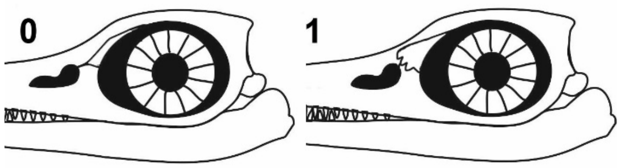
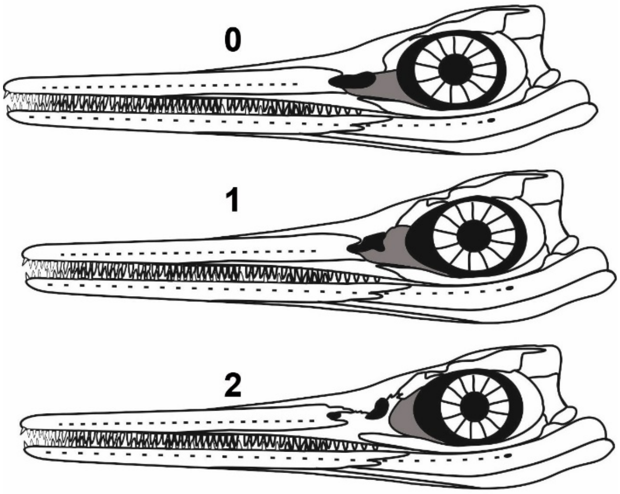
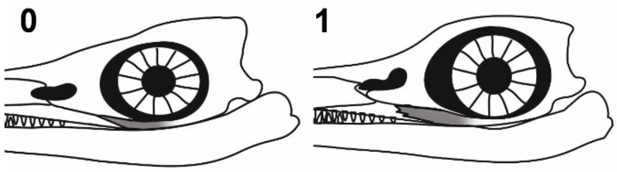
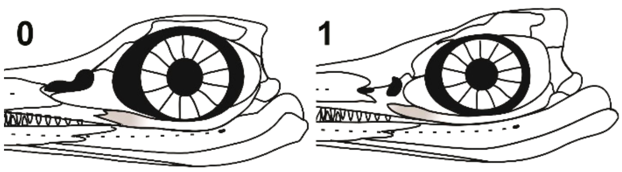
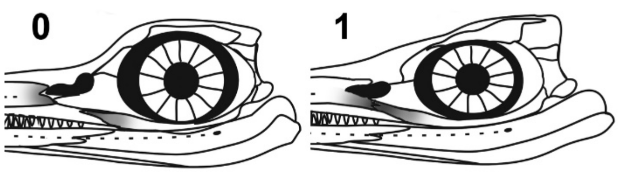
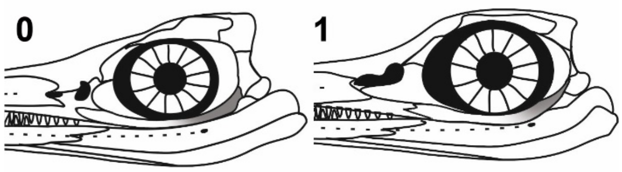
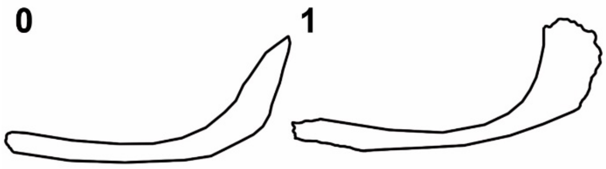
* – modified characters

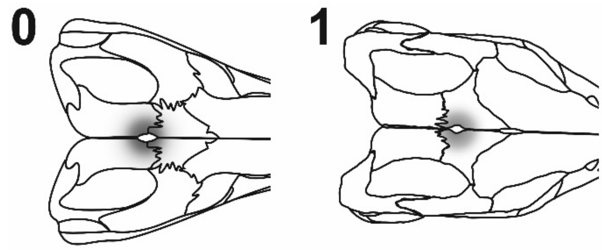
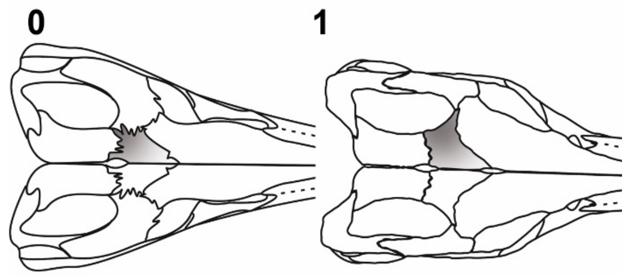
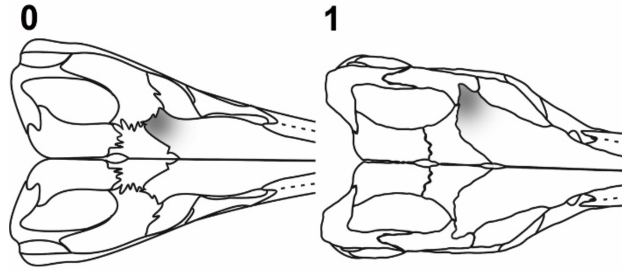
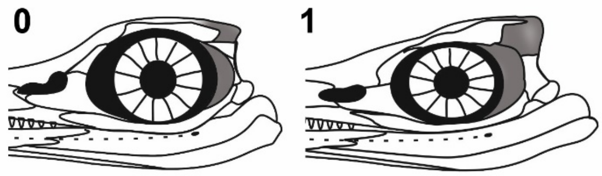
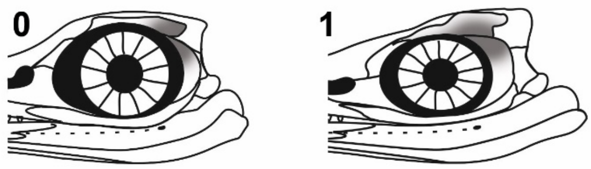
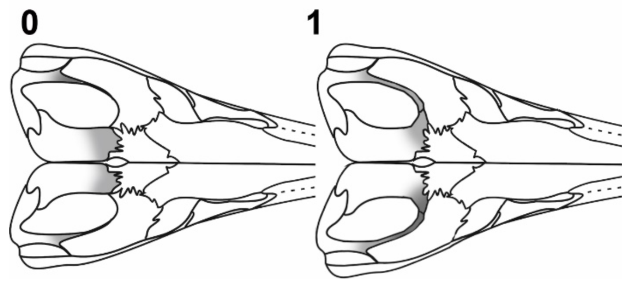
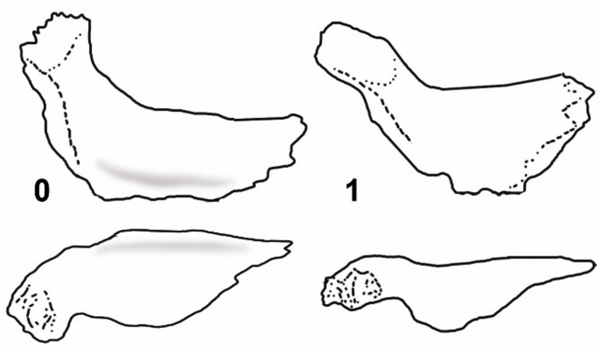
** – new characters

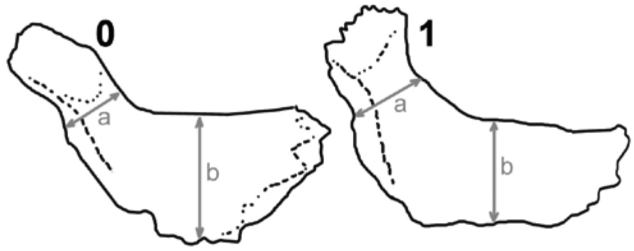
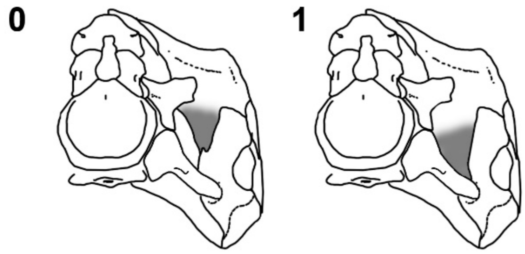
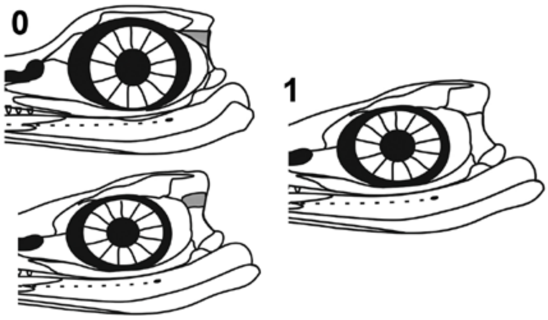
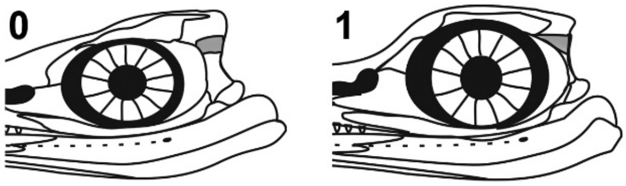
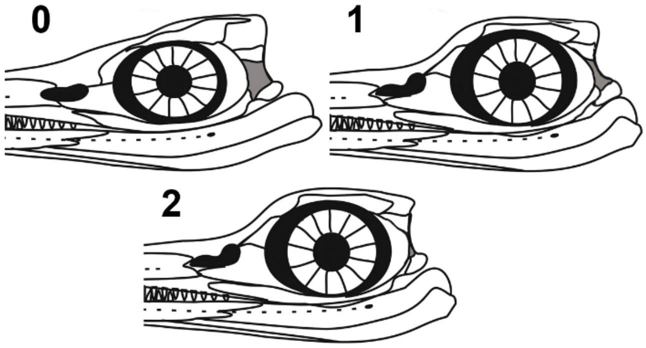
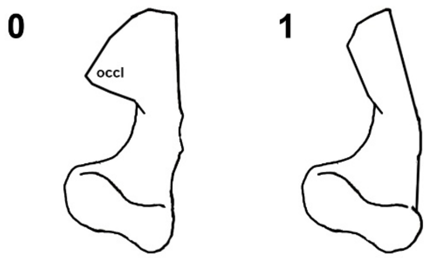
1	Crown striations: presence of deep longitudinal ridges (0); crown enamel subtly ridged or smooth (1). [Druckenmiller & Maxwell 2010, character 24]	
2	Base of enamel layer: poorly defined, invisible (0); well defined, precise (1). [Fischer *et al*. 2011, character 2]	
3	Shape of the root in cross-section in adults: rounded (0); quadrangular (1). [Fischer *et al*. 2011, character 3]	
4	Plicidentine. Vertical grooves present basal to the crown and apical to the root osteocementum (0); this region of the tooth appears smooth (1). [Maxwell *et al*. 2016, character 4]	
5	Plicidentine. Deep apicobasal grooves in root: present (0), absent (1). [Fischer *et al*. 2016, character 4]	
6	Tooth size relative to the skull length - (0) normal (over 0.1); (1) small (below 0.05). [Motani 1999, character 39] or alternative [Fischer *et al*. 2011, character 5]	
7	Processus supranarialis of the premaxilla: present (0); absent (1). [Maisch & Matzke, 2000, character 10]	

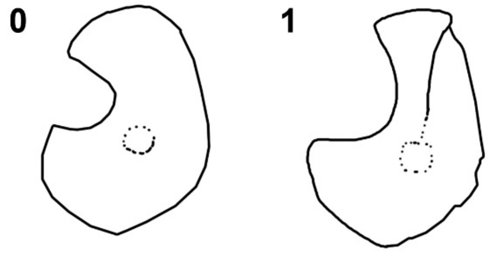
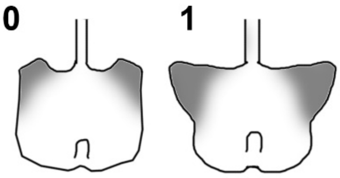
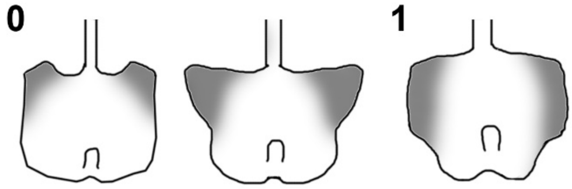
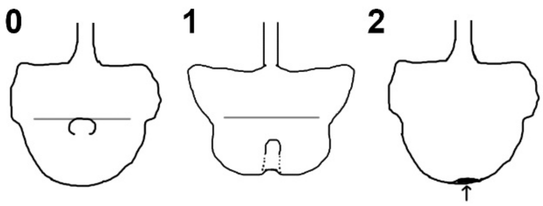
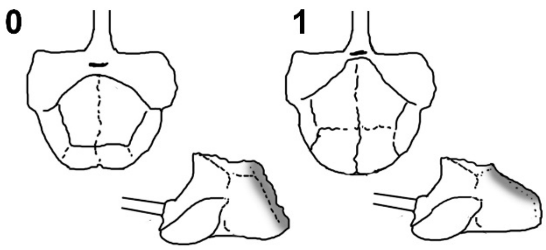
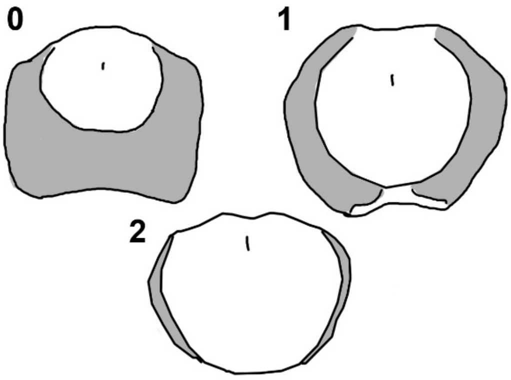
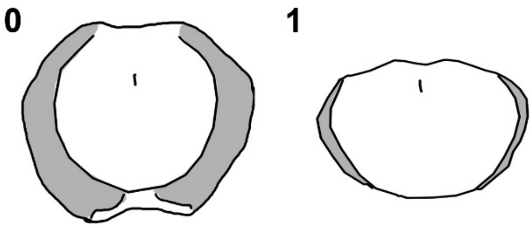
8	Processus subnarialis ends anteriorly to posterior end of naris (0), reaches posterior end of naris (1). [Fischer *et al*. 2016, char. 7]	
9	Processus postpalatinis pterygoidei: absent (0); present (1). [Maisch & Matzke 2000, character 38]	
10*	Maxilla – length of the premaxillary process in external view: (0) long, extends approximately 1.5 or more narial lengths anterior to the external naris (1) short, extends approximately one or less narial lengths anterior to the external naris [Maxwell 2012, character 2, inversed].	
11	Processus narialis of the maxilla in external view: present (0); absent (1). [Fisher *et al.* 2011, character 9, modified by Fischer *et al.* 2013]	

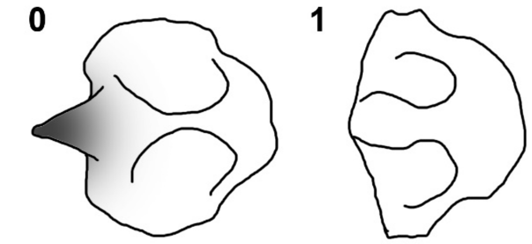
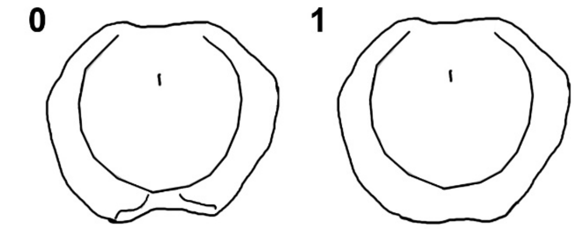
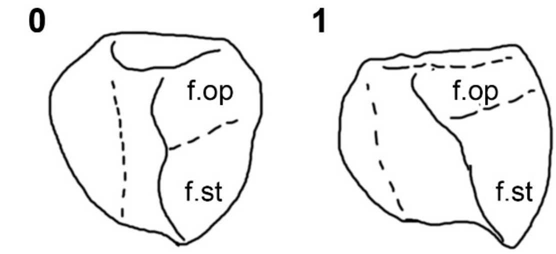
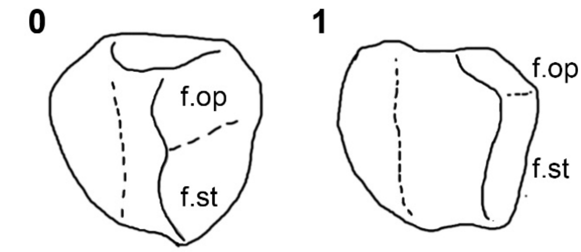
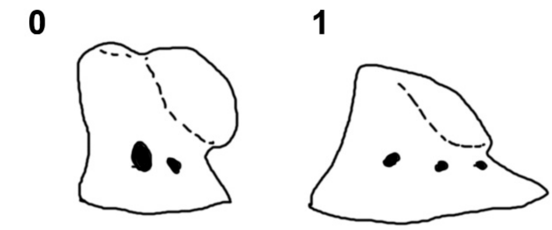
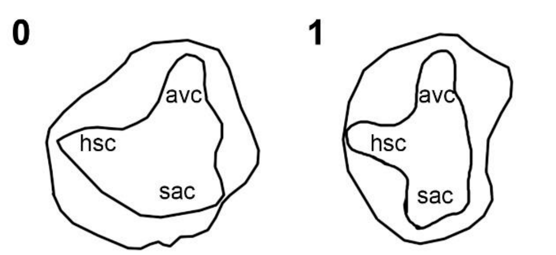
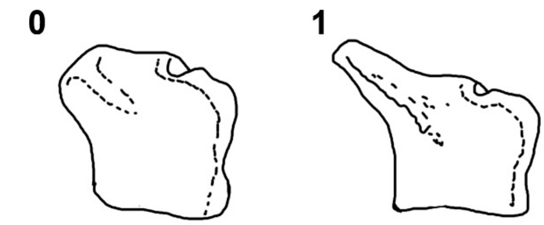
12	Descending process of the nasal on the dorsal border of the nares: absent (0); present (1). [Fernández 2007, character 2 = Fischer *et al*. 2016, character 14]	
13	Naso-maxillary pillar dividing the naris in two (regardless of the reduction of the anterior portion): absent (0), present (1). [Fischer *et al*. 2016, character 13]	
14**	Lateral 'wing' of the nasal over the dorsal boarder of the naris. Absent or poorly developed (0); well pronounced (1)	
15	Processus narialis of prefrontal: absent (0); present (1). [Fisher *et al.* 2011, character 11]	
16**	Prefrontal dorsomedial expansion absent (0); present (1)	

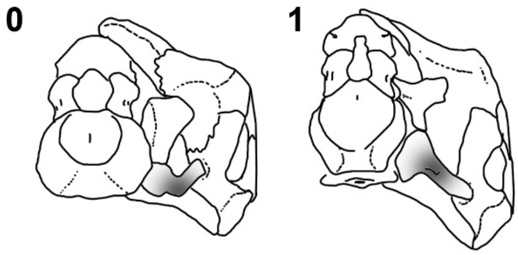
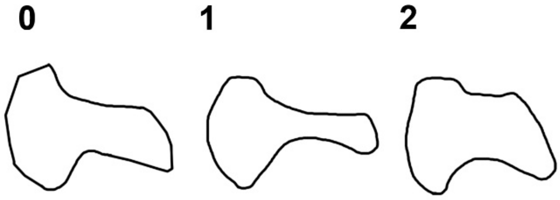
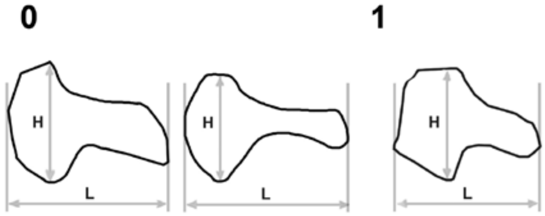
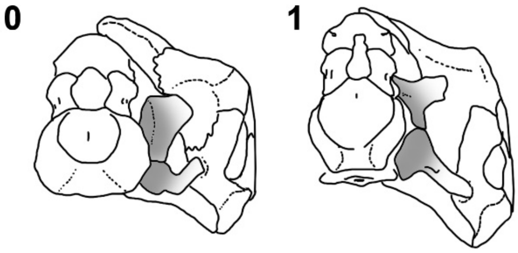
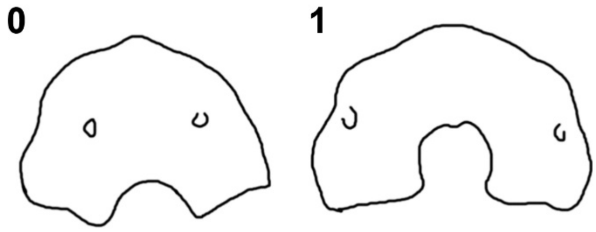
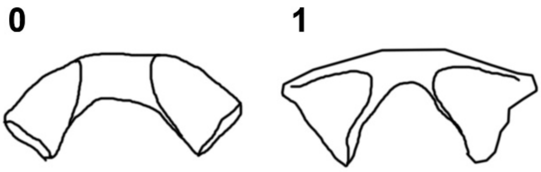
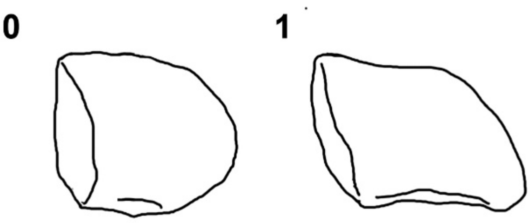
17	Lacrimal-prefrontal suture in external view: straight (0), strongly crenulated (1). [Fisher *et al.* 2016, character 16]	
18*	Lacrimal contribution to posterior border of the naris: forms shallow notch (0); forms deep notch (1); not contacts the naris (2) [Sander 2000, character 10, modified by Zverkov *et al*. 2015b, character 13 and further modified herein by adding an intermediate state (1)]	
19	Anterior margin of the jugal: tapering, running between lacrimal and maxilla (0); broad and fan-like, covering large area of maxilla ventrolaterally (1).[Druckenmiller & Maxwell 2010, character 6]	
20	Anterior margin of the jugal: termination, posterior to anterior end of lacrimal (0), reaches or surpasses anterior end of lacrimal (1). [Roberts *et al*. 2014, character 11]	
21**	Jugal/premaxilla contact absent (0); present (1)	
22	Posterior margin of the jugal articulates with the postorbital and quadratojugal (0); excluded from the quadratojugal by the postorbital (1). [Roberts *et al*. 2014, character 12]	
23**	Postorbital portion of the jugal: gracile (0); anteroposteriorly wide (1)	

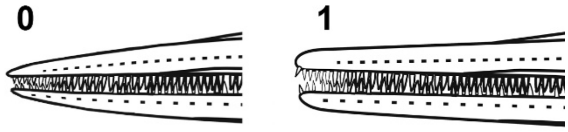
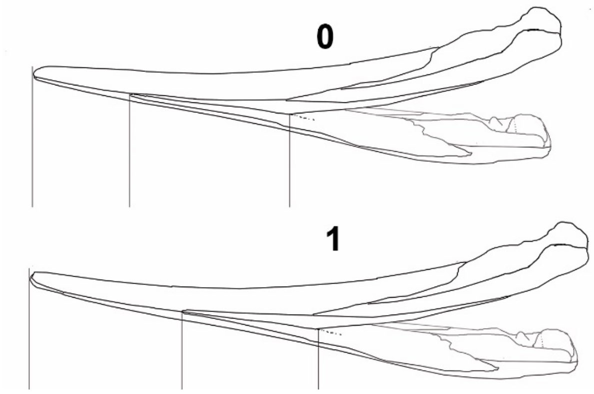
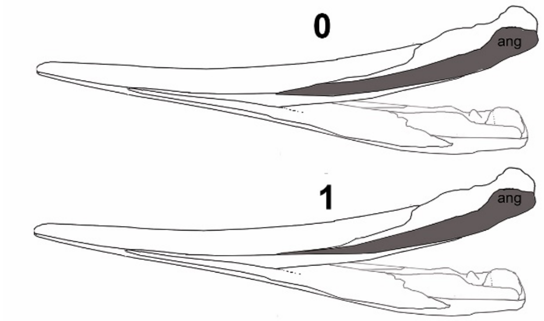
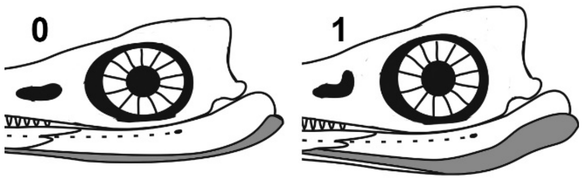
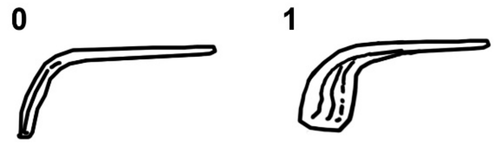
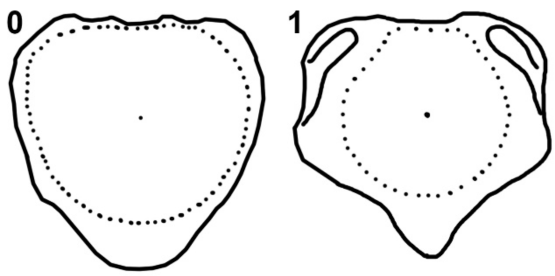
24**	Parietal foramen surrounding: parietal and frontal (0); completely surrounded by frontals in dorsal view (1). [similar to characters describing more basal conditions: Mazin 1982, character 2; Callaway 1989, character 2; Motani 1999, character 19]	
25	Processus temporalis of the frontal: absent (0); present (1). [Fisher *et al.* 2011, character 14]	
26*	Posterior process of the nasal overlapping postfrontal dorsally absent (0); present (1). [Fisher *et al.* 2016, character 21; re-defined]	
27	Supratemporal-postorbital contact: absent (0); present (1). [Sander 2000, character 27, inverted by Fischer *et al*. 2016, character 22]	
28	Broad postfrontal/postorbital contact in lateral view absent (0), present (1). [Roberts *et al*. 2014, character 16]	
29	Anterolateral supratemporal process that contacts parietal: absent (0), present (1). [Fischer *et al.* 2016, character 24]	
30	Sagittal eminence: present (0); absent (1). [Fernández 2007, character 5, inverted by Fischer *et al*. 2016, character 25]	

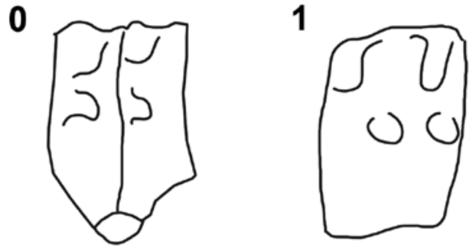
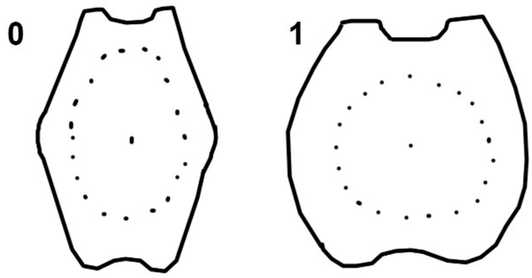
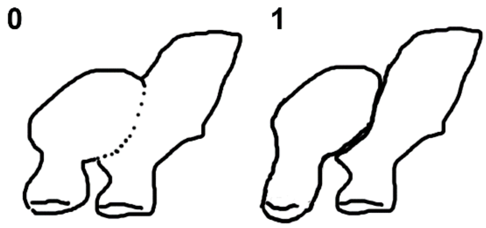
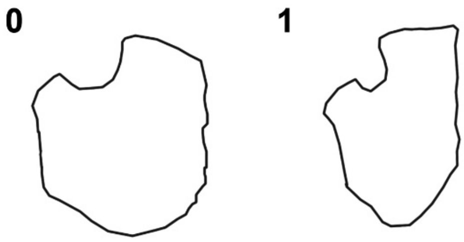
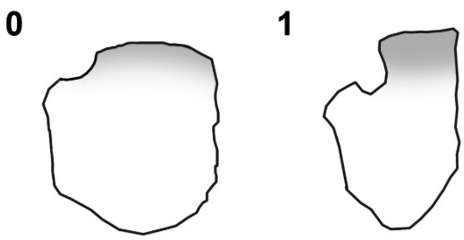
31**	Supratemporal process of the parietal: relatively slender[1] (0), robust[2] (1). [1]its width (a) in dorsal view constitute less than 0.65 of mediolateral width (b) of the main part of the element [2] (a) to (b) ratio is 0.7 or more	
32	Supratemporal–stapes contact: absent, the posteroventral process of the supratemporal does not extend up to the shaft of the stapes (0), present (1). [Fischer *et al*. 2016, character 26].	
33	Squamosal present (0), absent (1). [Moon 2017, character 69]	
34	Squamosal shape: squared (0); triangular (1). [Fischer *et al*. 2011, character 16, modified by Moon 2017, character 70]	
35*	Quadratojugal lateral exposure: extensive (0); small, largely covered by squamosal and postorbital (1); extremely reduced nearly unseen laterally (2). [Maisch & Matzke 2000, character 30; recently modified by Fischer *et al*. 2016, character 29, and further modified herein by adding state 2]	
36	Occipital lamella of the quadrate: present, giving the lateral surface of the quadrate a U-shape in posterior view (0), reduced, the dorsal part of the quadrate is a simple transversely-compressed lamella (1). [Fischer *et al*. 2016, character 31]	

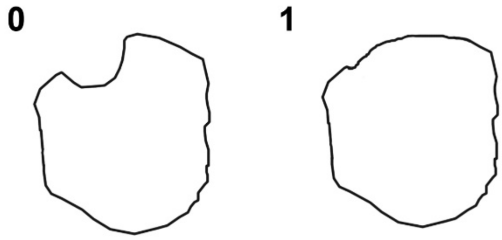
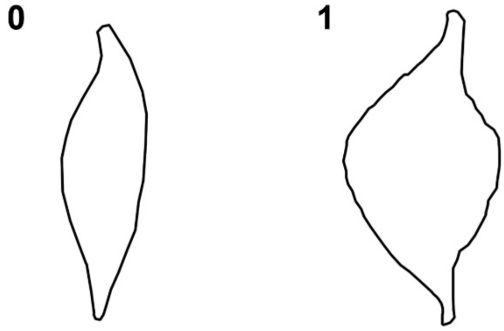
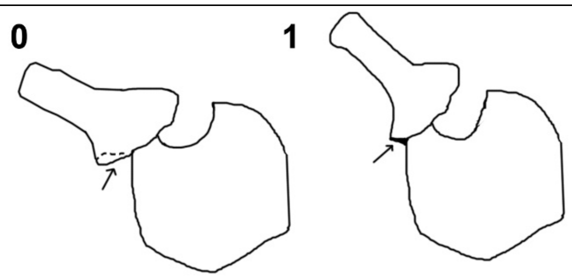
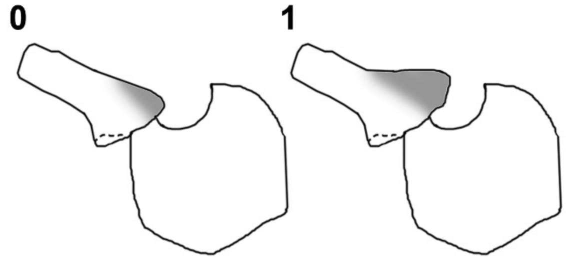
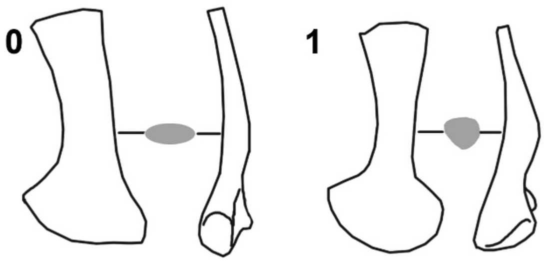
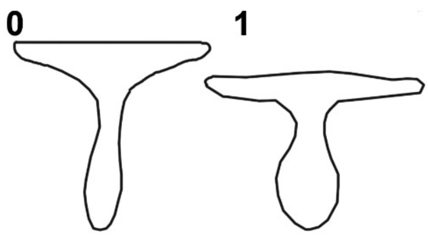
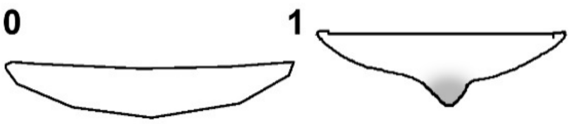
37**	Quadrate supratemporal groove absent(0); present (1).	
38	Basipterygoid processes: short, giving basisphenoid a square outline in dorsal view (0); markedly expanded anterolaterally, being wing-like, giving basisphenoid a marked pentagonal shape in dorsal view (1). [Fischer *et al*. 2011, character 18]	
39**	Basipterygoid processes: anteriorly directed (0); laterally or posterolaterally directed (1).	
40*	ICF foramen opens ventrally in the center (0) in posterior half, continuing with posterior groove (1) posteriorly (2). [Maxwell *et al.*, 2016 character 22, modified]	
41	Basisphenoid, dorsal view: dorsal plateau appears equal or wider than basioccipital facet, i.e. basioccipital facet oriented mostly posteriorly (0); basioccipital facet appears equal to or wider than dorsal plateau (1). [Maxwell *et al.* 2016, character 20]	
42	Extracondylar area of basioccipital: wide (0); reduced but still present ventrally and laterally (1); extremely reduced, being nonexistent at least ventrally (2). [Fernández 2007, character 10, modified by Fischer *et al*. 2011, character 19]	
43	Basioccipital condyle: width and height approximately equal (0); much wider than high (1). [Maxwell *et al.* 2016, character 24]	

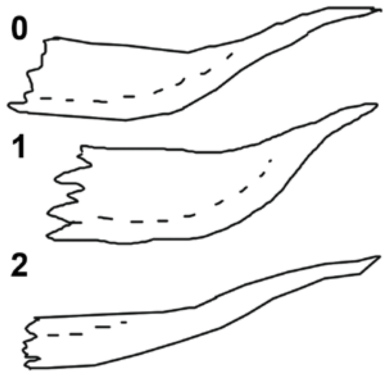
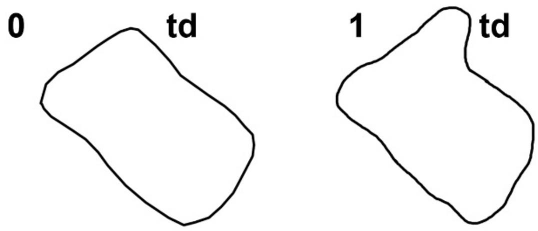
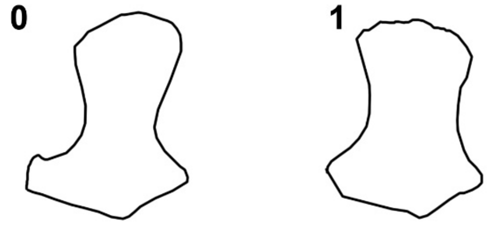
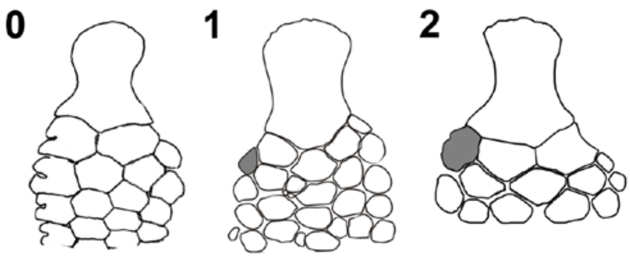
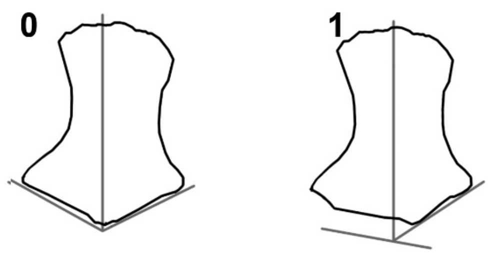
44	Basioccipital peg: present (0); absent (1). [Motani 1999, character 29, modified by Fischer *et al*. 2011, character 20]	
45	Ventral notch or ventral crest in the extracondylar area of the basioccipital: present (0); absent (1). [Fischer *et al*. 2012, character 19]	
46*	Raised opisthotic facet of the basioccipital absent (0) (i.e. they are nearly equal in height to stapedial facets in lateral view); present (1) practically unseen in lateral view. [Fischer *et al*. 2016, character 37, modified]	
47**	Opisthotic and stapedial facets lateral exposure: well seen (0); poorly seen, shifted anteriorly (1)	
48**	Exoccipital: columnar (0); squat (1).	
49	Prootic, osseous labyrinth shape: impression of the anterior vertical semicircular canal (avsc) to the sacculus (sac)-utriculus (ut) much longer than the width of the ut + sac, i.e., “T”-shapd (1); impression of the avsc to sac-ut distance equal or shorter than width of the ut+sac, i.e., “V”-shaped (0). [Maxwell *et al.* 2016, character 29]	
50	Shape of the paroccipital process of the opisthotic: short and robust (0); elongated and slender (1). [Fischer *et al*. 2012, character 20]	

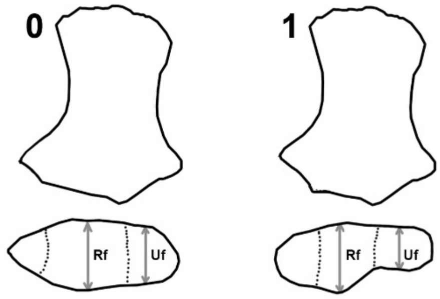
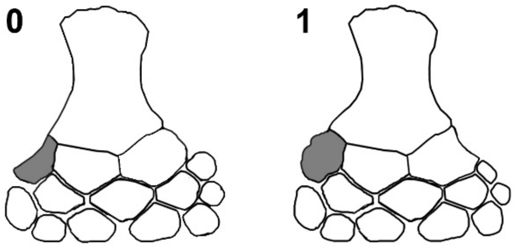
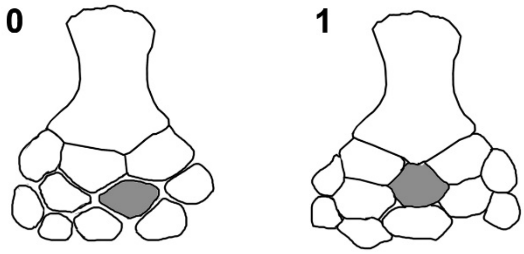
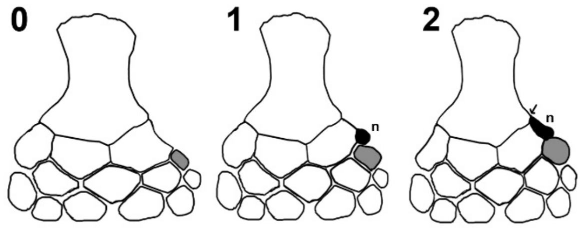
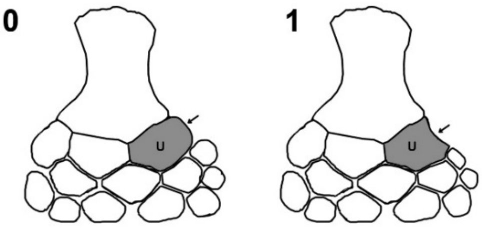
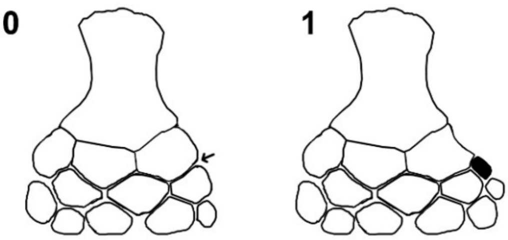
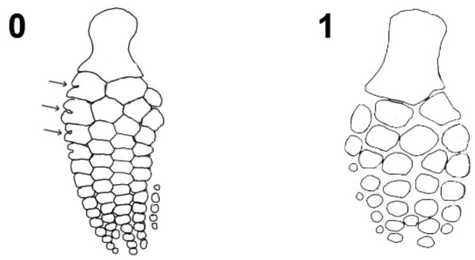
51**	Stapedial curvature: present (0); absent (1)	
52*	Stapedial shaft of adults in posterior view: moderately thick (0), slender and gracile, shaft dorsoventral minimal diameter consist 0,3 or less of the height of stapedial head (1), extremely thickened, shaft dorsoventral minimal diameter consist 0,45 or more of the height of stapedial head (2). [Roberts *et al*. 2014, character 25, modified]	
53**	Stapes proportions: mediolateral length to dorsoventral height: more than 1.3 (0), less than 1.3 (1).	
54	Stapes proximal head: slender, much smaller than opisthotic proximal head (0); massive, as large or larger than opisthotic (1). [Fischer *et al*. 2011, character 21]	
55	Supraoccipital-exoccipital processes – divergent (0); parallel (1). [Maxwell *et al.* 2012, character 19]	
56**	Supraoccipital otic portions: moderate or slender (0); relatively massive (1)	
57**	Articular shape in medial view 0 trapezoid or quadrate (0); parallelogram-like (1)	

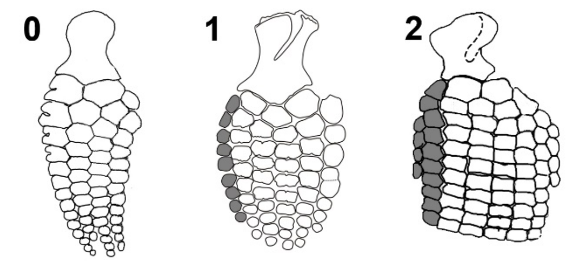
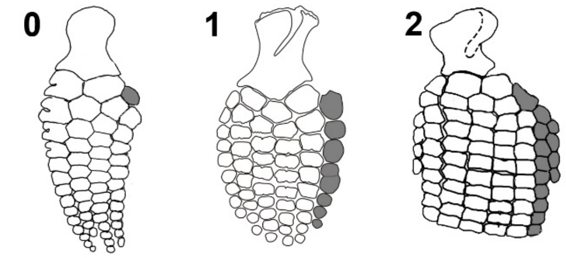
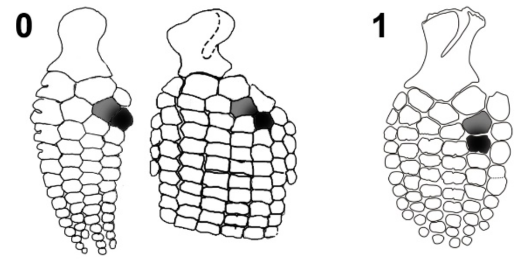
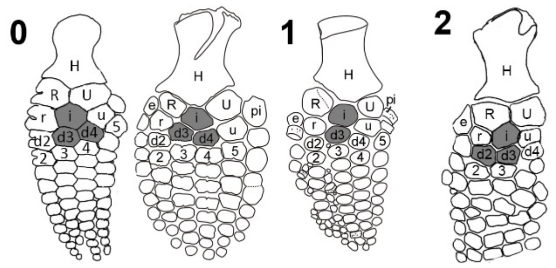
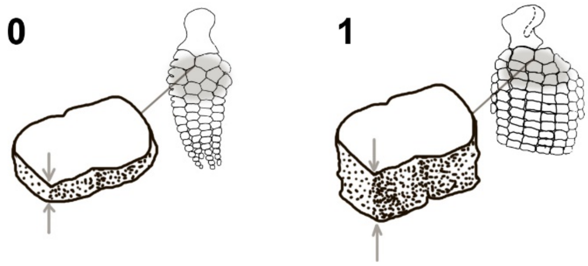
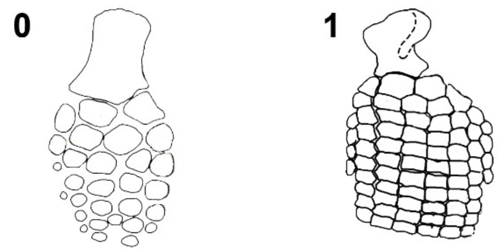
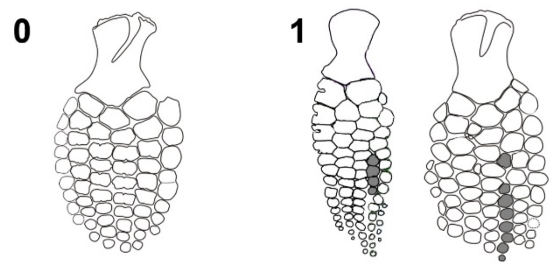
58	Anterior dentaries: sharply pointed at anterior tip (0); rounded (1). [Maxwell *et al.* 2016, character 33]	
59	Mandibular symphysis: splenial playing a more extensive role in the mandibular symphysis than the dentary (0), splenial participating in the mandibular symphysis but restricted to the posterior half (1). [Maxwell *et al.* 2012, character 34]	
60	Mandibular symphysis: angulars and splenials subequally exposed immediately anterior to the posteriormost symphysis (0); angulars much less prominent (1). [Maxwell *et al.* 2016, character 35]	
61	Angular lateral exposure: much smaller than surangular exposure (0); extensive (1). [Motani 1999, character 32, inverted by Fischer *et al*. 2011]	
62**	Orbital (peripheral) portion of scleral plate flattened (0); thickened (1).	
POSTCRANIAL CHARACTERS		
63	atlas-axis ventral keel absent (0); present (1). [Zverkov *et al*. 2015b, character 27]	

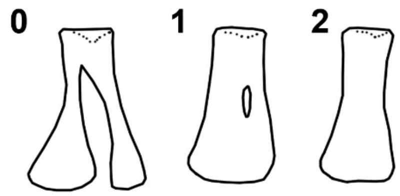
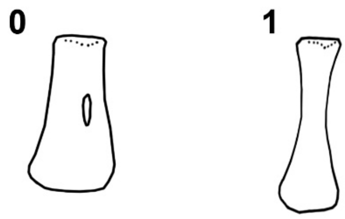
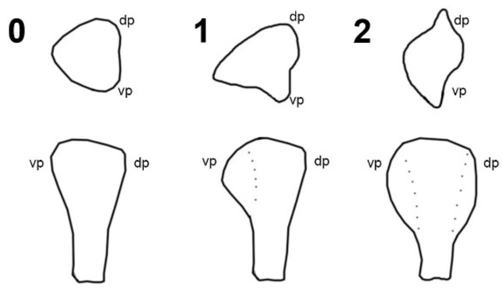
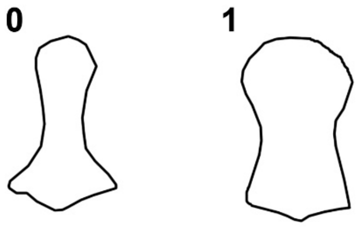
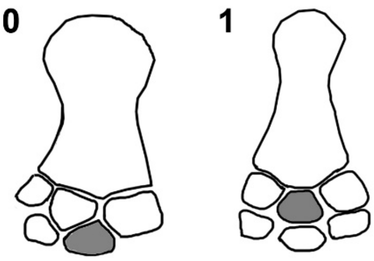
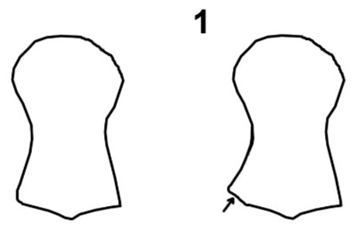
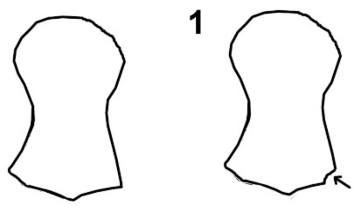
64**	atlas-axis fusion: with pronounced suture (0); no visible suture (1).	
65	Posterior dorsal/anterior caudal centra: 3.5 times or less as high as long (0); four times or more as high as long (1). [Maxwell 2010, character 16; inverted by Fischer *et al*. 2011]	
66	Tail fin centra: strongly laterally compressed (0); as wide as high (1). [Maxwell 2010, character 16]	
67	Neural spines of atlas-axis: completely overlapping, may be fused (0); functionally separate, never fused (1). [Druckenmiller & Maxwell 2010, character 26]	
68	Chevrons in apical region: present (0); lost (1). [Sander 2000, character 72]	
69	Coracoid shape in adults: rounded (length to width ratio less than 1.3 and often close to 1) (0), anteroposteriorly elongated (length to width ratio greater or equal to 1.5) (1). [Arkhangelsky & Zverkov 2014, character 53, modified by Fischer *et al.* 2016, character 52]	
70*	Anteromedial process of coracoid poorly pronounced, anteroposteriorly short (0); protruding anteriorly (1). [Fischer *et al*. 2016, character 53, modified]	

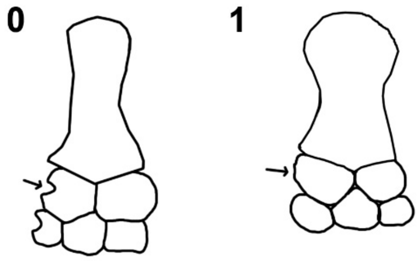
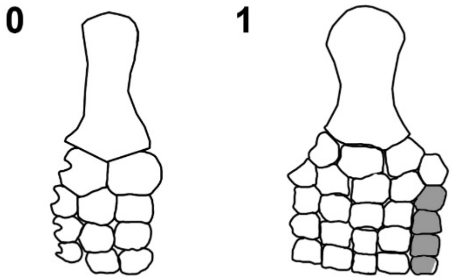
71*	Anterior notch of the coracoid present and prominent (0); extremely reduced or absent (1). [Fischer *et al*. 2011, character 31, modified]	
72**	Coracoid medial facet relatively thin (0); extremely thickened dorsoventrally (1).	
73	Glenoid contribution of the scapula: extensive, being at least as large as the coracoid facet (0); reduced, being markedly smaller than the coracoid facet (1). [Fischer *et al*. 2012, character 27]	
74	Prominent acromion process of scapula: absent (0); present (1). [Fischer *et al*. 2011, character 31]	
75**	Scapular shaft strap-like (0); rod-like (1)	
76**	Interclavicle p.m.s. shape strap-like or rod-like but relatively slender (0); markedly expanded (1)	
77**	Interclavicle ventral knob: no (0); present (1)	

78*	Clavicle plate like ‘standard’ (0); plate like and very high medially[2], (1); rod-like (2). [Maisch & Matzke 2000, character 68, modified herein] [1]medial dorsoventral height to anteroposterior length ratio = 0,2 or less [2] medial dorsoventral height to anteroposterior length greater than 0,2	
79	Plate-like trochanter dorsalis: absent (0); present (1). [Motani 1999, character 56]	
80	Protruding triangular deltopectoral crest on humerus: absent (0); present (1); present and very large, matching in height the trochanter dorsalis, and bordered by concave areas (2). [Fischer *et al*. 2011, character 31, modified by Fischer *et al*. 2012].	
81	Humerus distal and proximal ends in dorsal view (thus regardless of the size of the dorsal and ventral processes): distal end wider than proximal end (0); nearly equal or proximal end slightly wider than distal end (1). [Motani 1999, character 55, modified by Fischer *et al*. 2011, character 32]	
82	Anterior accessory epipodial element anterior to radius: absent (0), present (1); present with associated facet on humerus (2) [Godefroit 1993, character 10, modified by Fischer *et al*. 2012, 2016 (char. 60)].	
83	Humerus with posterodistally deflected ulnar facet and distally facing radial facet: no (0); yes (1). [Fischer *et al*. 2011, character 34, modified by Fischer *et al*. 2012]	

84**	Ulnar/radial facet width ratio nearly equal (0); less than 0.83 (1).	
85**	Shape of aae if present: lunate (0); rounded (1).	
86	Humerus/intermedium contact: absent (0); present (1). [Fernández 2007, character 15]	
87	Posterior accessory epipodial element posterior to ulna: absent (0), present (1), present with associated facet on humerus (2). [Fischer *et al*. 2016, character 64]	
88	Shape of the posterior surface of the ulna: rounded or straight and nearly as thick as the rest of the element (0); concave and edgy (1). [Fischer *et al*. 2012, character 36]	
89	Manual pisiform: absent (0); present (1). [Motani 1999, character 67, inverted by Fischer *et al*. 2011, character 36]	
90	Notching of anterior facet of leading edge elements of forefin in adults: present (0); absent (1). [Motani 1999, characters 59 and 65, modified by Fischer *et al*. 2011, character 37]	

91	Preaxial accessory digits on forefin: absent (0), one (1); two or more (2) [Maisch & Matzke 2000, character 91, modified by Fischer *et al*. 2016, character 69]	
92	Posterior enlargement of forefin: number of postaxial accessory ‘complete’ digits: none (0); one (1), two or more (2). [Maisch & Matzke, 2000, character 89, modified by Fischer *et al*. 2011, character 38]	
93*	‘Longipinnate’ or ‘latipinnate’ forefin architecture; ulnare/mc5 contact: posterodistal (0); distal (1). [Fischer *et al*. 2011, character 40, modified by Zverkov *et al.* 2015*b*, character 49].	
94*	Intermedium/dc contact, 3,4 – (0); 3 – (1); 3,2 – (2). [Sander 2000, character 93, modified by Zverkov *et al.* 2015*b*, character 50].	
95	Zeugo- to autopodial elements flattened and platelike (0); strongly thickened (1). [Maisch & Matzke, 2000, character 94]	
96	Tightly packed rectangular phalanges: absent, phalanges are mostly rounded (0); present (1). [Maisch & Matzke 2000, character 102, modified by Fischer *et al*. 2011, character 42]	
97	Digital bifurcation: absent (0); frequently occurs in digit IV (1). [Fischer *et al*. 2011, character 43]	

98	Ischium-pubis fusion in adults: absent or present only proximally (0); present with an obturator foramen (1); present with no obturator foramen (2). [Mazin, 1982 character 13, modified by Fischer *et al*. 2011, character 44]	
99	Ischium or ischiopubis shape: plate-like, flattened (0); rod-like (1). [Motani 1999 character 87, modified by Fischer *et al*. 2011, character 45]	
100*	Dorsal and ventral processes on femur: poorly pronounced (0); ventral process is pronounced, plate-like, while dorsal is still not prominent (1); both processes plate-like, demarked from the head of the femur and extending up to mid-shaft (2). [Modification of Fischer et al. 2011, character 46, and Roberts *et al*. 2014, character 52]	
101	Wide distal femoral blade present (0), absent, the distal extremity of the femur being smaller than the proximal one in dorsal view (1). [Fischer *et al*. 2013, character 61]	
102	Intermedium/femoral contact: absent (0); present (1). [Maxwell 2010, character 33]	
103	Femur anterodistal facet for accessory zeugopodial element anterior to tibia: absent (0); present (1). [Fischer *et al*. 2011, character 48]	
104**	Femur posterodistal facet for accessory zeugopodial element posterior to fibula: absent (0); present (1)	

105	Hind fin leading edge element in adults: notched (0); straight (1). [Motani 1999 character 92, modified by Fischer *et al*. 2013]	
106*	Postaxial 5th digit: absent of poorly ossified (0); present and well developed (1). [Fischer *et al*. 2011, character 50, modified]	

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