Supplementary Material 1

A new traversodontid cynodont with a peculiar postcanine dentition from the Middle/Late Triassic of Namibia and dental evolution in basal gomphodonts

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1. List of cynodonts included in this study

	Genus	species	Ex.	Specimens	Photo credits	Literature
1	*Thrinaxodon*	*liorhinus*	Y	NHMUK R511, R511a, R845, R1715, R3731, R5480; BP/1/472, 1375, 1376, 4280, 5208, 5372; AMNH R9563; BSP 1934VIII 506; MCZ 8892; RC 107; TM 80, 81, 1486; NMQR 810, 811, 812, 1533; SAM-PK-K-378, 380, 381, 1121, 1388, 1461, 1467, 1468, 1483, 1498, 1499, 3592, 10016, 10017; UMCZ T.811, T.813–T.817.		(Abdala *et al.* 2013; Jasinoski *et al.* 2015)
2	*Cynognathus*	*crateronotus*	Y	AM 460, 2190, 3587, 4202, 5800; AMNH 5641; NHMUK R2571, R3580; BP/1/1181, 2095, 3755, 4664; BSP 1934 VIII 1, VIII 2, VIII 3, VIII 4, VIII 6; NMQR 1444; PVL 3859; SAM-PK-6224, 6235, 11264, 11484		
3	*Diademodon*	*tetragonus*	Y	AM 3753; NHMUK R2578, 3304, 3587, 3588, 3765, BP/1/3754, 3769, 4669; BSP 1934 VIII 14, VIII 15, VIII 16, VIII 17, VIII 19; MB R1004; SAM PKK5223, K5716	Christian Kammerer	
4	*Titanogomphodon*	*crassus*	Y	GSN R323		
5	*Cricodon*	*metabolus*	Y	CAMZM (UMCZ) T905; BP/1/5538, 5540, 5835, 6102, 6159; NHCC LB28	Christian Sidor	(Sidor & Hopson 2018)
6	*Trirachodon*	*berryi*	Y	AM 434; NHMUK R3306, R3307, R3350, R3579, R3721, R3722; BP/1/3511, 3775, 4258, 4658, 4661, 5050; BSP 1934 VIII 21, 22, 23; GSN R327; NMQR 122, 1399, 3279; SAM-PK-4801, 5873, 5881, 7888, K171; AM 461; SAM-PK-K171; SAM-PK-12168; NHMUK R3307		
7	*Langbergia*	*modisei*	Y	NMQR 3255, 3251, 3256, 3268, 3280, 3281; BP/1/5362, 5363, 5400, 5401, 5404; CGS/1/33 120; SAM PK 11481		
8	*Sinognathus*	*gracilis*	Y	IVPP V2339		
9	*Beishanodon*	*youngi*	**N**	PKUP V3007		(Gao *et al.* 2010)
10	Traversodontidae	indet.	Y	CGS JSM 100		(Hopson 2005)
11	Traversodontidae	indet.	Y	BP/1/5538		
12	*Etjoia*	*dentitransitus*	Y	GSN F1591		
13	*Nanogomphodon*	*wildi*	Y	SMNS 51962		
14	*Scalenodon*	*angustifrons*	Y	CAMZM T907; CAMZM T908–918, T925, T946		
15	*Scalenodon*	*ribeiroae*	**N**	UFRGS-PV-0239-T		(Melo *et al.* 2017)
16	*Pascualgnathus*	*polanskii*	Y	MLP 65-VI-18-1, 65-VI-18-2; PVL 3466; PVL 4416	Agustín Martinelli	
17	*Andescynodon*	*mendozensis*	Y	PVL 3834–3836, 3840, 3890, 3891, 3892(a, b, c, d), 3894–3900, 3894-1, 3895–3900, 3903, 3907, 4069–4072, 4390, 4423–4432		
18	*Luangwa*	*drysdalli*	Y	BP/1/3731; BP/1/3733; TSK 121		

19	*Luangwa*	*sudamericana*	Y	MCP 3167PV; UFRGS-PV 0267T	
20	*Traversodon*	*stahleckeri*	Y	GPIT/RE/7170; GPIT 1045, 1063, 1069; UFRGS-PV 0224T	
21	*Mandagomphodon*	*hirschsoni*	Y	NHMUK R8577	(Hopson 2014)
22	*Mandagomphodon*	*attridgei*	Y	NHMUK R8578; CAMZM T922	
23	*Dadadon*	*isaloi*	Y	UA 10606; UA 10605	(Ranivoharimanana *et al.* 2011; Kammerer *et al.* 2012)
24	*Santacruzodon*	*hopsoni*	Y	MCN PV 2768; MCN PV 2751, MCN PV 2752, MCN PV 2770 ; MCP 4044 PV, MCP 4034 PV	
25	*Massetognathus*	*pascuali*	Y	PULR 10; PULR 13 (former MLP No. 65-XI-14-2); PULR 11 (former MLP No. 65-XI-14-15); PULR unnumbered (former MLP No. 65-XI-14-16); PVL 3901–3906, 4014, 4016, 4168, 4439–4443, 4613, 4614, 4676, 4726–4729, 5441, 5443–5445, 5683; MCZ 3691, 3786, 3798, 3801, 3804, 3806, 3807, 4021, 4138, 4208, 4215, 4216, 4258, 4265; NHMUK R8430; BP/1/4245; MCP 3284	Rafael Delcourt
26	*Massetognathus*	*ochagaviae*	Y	MCP 3871 PV; UFRGS-PV 0255T; UFRGS-PV 0070T, 0071T, 0125T, 0239T, 0241T, 0242T, 0243T, 0245T, 0265T, 0273T, 0397T, 1064T; AMNH FARB 7802, 7803, 21400–21410	
27	*Boreogomphodon*	*jeffersoni*	Y	USNM 437632; CM 20050, 76800, 76801, 76803; USNM 437635, 437636, 448562, 448570, 448593, 448599, 448632, 448633; VMNH 3575, 3578; CM 76805, 76807, 76808, 76810, 76812, 76815, 76818; USNM 448563–448569, 448571–448573, 448575, 448576, 448578, 448597, 448601, 448625, 448629; USNM 448598, 448602; VMNH 3577; NCSM 11466, 15295, 16292, 16297, 16358, 16364, 18300, 19587, 20660, 20662, 20692, 20698, 20700, 20704, 20712, 21370, 21371	(Liu & Sues 2010; Sues & Hopson 2010)
28	*Plinthogomphodon*	*herpetairus*	**N**	UNC 15576; UNC 15656	(Sues *et al.* 1999)
29	*Arctotraversodon*	*plemmyridon*	Y	YPM-PU 19190; YPM-PU 19190-A; YPM-PU 21693; NSM 983GF2.1; NSM 990GF89.1; YPM-PU 22343	
30	*Gomphodonto-suchus*	*brasiliensis*	Y	GPIT/RE/09397	
31	*Menadon*	*besairiei* (Madagascar)	Y	UA 10601; FMNH PR 2104; FMNH PR 2444	
32	*Menadon*	*besairiei* (Brazil)	Y	UFRGS-PV-0269-T, 0434-T, 0891-T, 0903-T, 0905-T, 1054-T, 1164-T, 1165-T; MCN-	(Melo *et al.* 2015)

				PV 0505, 2750		
33	*Protuberum*	*cabralense*	**N**	MGB 368-100; UFRGS-PV 0981T; UFRGS-PV 0983T; UFRGS-PV 0985T; UFRGS-PV 0986T; UFRGS-PV 1009T; UFRGS-PV 1010T; UFRGS-PV 1011T	Tomaz Melo	
34	*Ruberodon*	*roychowdhurii*	**N**	IITKGPR381, 375, 376, 378, 380		(Ray 2015)
35	*Scalenodontoides*	*macrodontes*	Y	MNHN 1957-23; SAM-PK-K336; BP/1/5395; MNHN 1955-25; NMQR 3053		
36	*Exaeretodon*	*argentinus*	Y	MLP 43-VII-14-2; MLP 43-VII-14-1, 43-VII-14-3, 43-VII-14-4; MACN 18063, 18114, 18125; PVL 2564; MCZ 7047; MCZ 3779, 4493, 111-64A, 377-58 M; MCP 1522PV; PVSJ 157		
37	*Exaeretodon*	*riograndensis*	Y	MCP 1522PV; MCP 2361 PV; MCP 3843 PV; UFRGS-PV 0715T		
38	*Siriusgnathus*	*niemeyerorum*	**N**	CAPPA/UFSM 0032, 0109, 0124, 0125, 0260		(Pavanatto *et al.* 2018; Miron *et al.* 2020)
39	*Habayia*	*halbardieri*	Y	IRSNB R203		
40	*Maubeugia*	*lotharingica*	Y	IRSNB R172		
41	*Rosieria*	*delsatei*	Y	IRSNB R173, R174		
42	*Microscalenodon*	*nanus*	Y	IRSNB R405, R406		

Abbreviations: Ex., Examined; N, No; Y, Yes. The list of institutional abbreviations is listed below.

List of institutional abbreviations

AM: Albany Museum, Grahamstown, South Africa; **AMNH**: American Museum of Natural History, New York, New York, USA; **BP**: Evolutionary Studies Institute (formerly Bernard Price Institute for Palaeontological Research), University of the Witwatersrand, Johannesburg, South Africa; **BSP**: Bayerische Staatssammlung für Paläontologie und Geologie, Munich, Germany; **CAMZM**: University Museum of Zoology, Cambridge, UK; **CAPPA/UFSM**: Centro de Apoio à Pesquisa Paleontológica, Universidade Federal de Santa Maria, São João do Polêsine, Brazil; **CGS**: Council for Geosciences, Pretoria, South Africa; **CM**: Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA; **FMNH**: Field Museum of Natural History, Chicago, Illinois, USA; **GPIT**: Institut und Museum für Geologie und Paläontologie der Universität Tübingen, Tübingen, Germany; **GSN**: Geological Survey of Namibia, Windhoek, Namibia; **IITKGPR**: Indian Institute of Technology Kharagpur, Kharagpur, India; **IRSNB**: Royal Belgian Institute of Natural Sciences, Brussels, Belgium; **IVPP**: Institute for Vertebrate Paleontology and Paleoanthropology, Beijing, China; **MACN**: Museo Argentino de Ciencias Naturales "Bernardino Rivadavia", Buenos Aires, Argentina; **MB**: Museum für Naturkunde, Berlin, Germany; **MCN**: Museu de Ciências Naturais, Fundação Zoobotânica do Rio Grande do Sul, Porto Alegre, Brazil; **MCP**: Laboratório de Paleontologia, Museu de Ciências e Tecnologia, Pontifícia Universidade Católica do Rio Grande do Sul, Porto Alegre, Brazil; **MCZ**: Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA; **MGB**: Museu Guido Borgomanero, Mata, Brazil; **MHNSR–Pv**: Museo de Historia Natural de San Rafael, Mendoza, Argentina; **MLP**: Museo de La Plata, La Plata, Argentina; **MNHN**: Muséum National d'Histoire Naturelle, Paris, France; **NCSM**: North Carolina Museum of Natural Sciences, Raleigh, North Carolina, USA; **NHCC**: National Heritage Conservation Commission, Lusaka, Zambia; **NHMUK PV**: Natural History Museum, London, UK; **NMQR**: National Museum, Bloemfontein, South Africa; **NMT**: National Museum of Tanzania, Dar es Salaam, Tanzania; **PKUP**: Peking University Paleontological Collections, Beijing; **PULR**: Museo de Antropología, Universidad Nacional de La Rioja, La Rioja, Argentina; **PVL**: Colección de Palaeontología de Vertebrados, Instituto Miguel Lillo, Universidad Nacional de Tucumán, Argentina; **PVSJ**: Museo de Ciencias Naturales, Universidad Nacional de San Juan, San Juan, Argentina; **RC**: Rubidge Collection, Wellwood, Graaff Reinet, South Africa; **SAM-PK**: Iziko, the South African Museum, Cape Town, South Africa; **SMNS**: Staatliches Museum für Naturkunde Stuttgart, Stuttgart, Germany; **TM**: Ditsong National Museum of Natural History, Pretoria (formerly Transvaal Museum), South Africa; **UA**: Université d'Antananarivo, Antananarivo, Madagascar; **UFRGS-PV**: Setor de Paleovertebrados, Instituto de Geociências, Universidade Federal do Rio Grande do Sul, Porto Alegre, Brazil; **UMZC**: University Museum of Zoology, Cambridge, UK; **UNC**: Collections of the Department of Geology, University of North Carolina, Chapel Hill, USA; **USNM**: National Museum of Natural History, Washington D.C., USA; **VMNH**: Virginia Museum of Natural History, Martinsville, Virginia, USA; **YPM-PU**: former Princeton University collection, now housed in the Peabody Museum of Natural History, Yale University, New Haven, Connecticut, USA.

2. Character list of our dataset

I. INCISORS

Generality

1) Incisors, cross-section of mesialmost incisor at mid-crown (**New**):
   (0) salinon or D-shaped
   (1) subcircular, ovoid, lanceolate or thick lenticular
   (2) parlinon-shaped or narrow lenticular

2) Incisors, constriction at the crown base in some teeth (**New**; ORDERED):
   (0) absent
   (1) present, weak
   (2) present, important (= folidont teeth)

3) Incisors, denticles (Gaetano and Abdala, 2015; #39):
   (0) present and small, more than 20 mesial/distal denticles along the crown height
   (1) present and large, less than 20 mesial/distal denticles along the crown height
   absent

4) Incisors, denticles (**New**):
   (0) present on the mesial and distal carinae
   (1) present on the distal carina only

5) Incisors, denticle orientation (**New**):
   (0) perpendicular to carina
   (1) diagonally oriented

6) Incisors, numerous longitudinal ridges on labial surface in some teeth (**New**):
   (0) absent
   (1) present

Upper incisors

7) Upper incisors, crown base length (CBL) in adults (Gaetano & Abdala, 2015; #40):
   (0) small, CBL shorter than that of canines
   (1) enlarged, CBL of incisors as long or longer than that of canines

8) Upper incisors, number (Gaetano & Abdala, 2015; #36; ORDERED):
   (0) two
   (1) three
   (2) four
   (3) five

9) Upper incisors, procumbency (Gaetano & Abdala, 2015; #38):
   (0) absent or very light
   (1) present, strongly procumbent teeth
   (2) present, only first incisor procumbent

10) Upper incisors, diastema before upper canines (Gaetano & Abdala, 2015; #26):
   (0) present, longer than the last upper incisor CBL
   (1) absent or short, shorter than the last upper incisor CBL

Lower incisors

11) Lower incisors, CBL in adults (Gaetano & Abdala, 2015; #40):
- (0) small, CBL shorter than that of canines
- (1) enlarged, CBL of incisors as long or longer than that of canines

12) Lower incisors, number (Gaetano & Abdala, 2015; #37):
- (0) two
- (1) three
- (2) four

13) Lower incisors, procumbency (**New**):
- (0) present
- (1) absent or very light

II. CANINES

Generality

14) Canines, denticles (Gaetano & Abdala, 2015; #43):
- (0) present, more than 15 denticles per 5 mm along the distal carina
- (1) present, 15 or less denticles per 5 mm along the distal carina
- (2) absent

15) Canines, denticle size along the carina (**New**):
- (0) regular, gradual change in denticle size
- (1) irregular, sporadic change in denticle size

16) Canines, mesial denticles significantly larger than distal denticles (DSDI>1.2) in adults (**New**):
- (0) absent
- (1) present

17) Canine, longitudinal ridges on some crowns (**New**):
- (0) absent
- (1) present, poorly defined ridges
- (2) present, well-delimited ridges

18) Canine, transverse undulations in adults (**New**):
- (0) present
- (1) absent

Upper canine

19) Upper canines, position in relation to paracanine fossa (Gaetano & Abdala, 2015; #25; ORDERED):
- (0) labiodistal
- (1) labial
- (2) labiomesial

20) Upper canines, diastema before upper postcanines in adults (Gaetano & Abdala, 2015; #27; ORDERED):
- (0) short, less than the mesiodistal length of the upper canine alveoli

(1) medium, more than the mesiodistal length of the upper canine alveoli but less than twice this length
(2) long, more than twice the mesiodistal length of the upper canine alveoli

21) Upper canines, size in adult (Gaetano & Abdala, 2015; #41):
(0) large, upper canine height more than twice the upper incisor height
(1) reduced in size, upper canine height less than twice upper incisor's height
(2) upper canine absent

Lower canine

22) Lower canines, diastema before lower postcanines in adults (Gaetano & Abdala, 2015; #28):
(0) long, longer than the lower canine CBL
(1) absent or short, shorter than the lower canine CBL

23) Lower canines, size (Gaetano & Abdala, 2015; #42):
(0) large, lower canine height more than twice the lower incisor height
(1) reduced in size, lower canine height less than twice the lower incisor height
(2) lower canine absent

24) Lower canines, procumbency (**New**):
(0) absent, crown apex projecting dorsally
(1) present, crown apex projecting mesiodorsally

Paracanine fossa

25) Paracanine fossa in cranium (**New**):
(0) deep and well delimited
(1) shallow and poorly delimited

26) Paracanine fossa in cranium (**New**):
(0) mesiodistally longer than mesiodistal length of upper canine alveoli
(1) same mesiodistal length or shorter than mesiodistal length of upper canine alveoli

III. UPPER POSTCANINES

Generality

27) Upper postcanines, number (**New**):
(0) 11 or less
(1) more than 11

28) Upper postcanines, variation in the number of teeth during ontogeny (**New**):
(0) number of teeth remaining stable during ontogeny
(1) number of teeth increasing during growth
(2) number of teeth decreasing during growth

29) Upper/lower postcanines, formed by (**New**; ORDERED):
(0) sectorial only
(1) conical (more than two conical postcanines), gomphodont and sectorial
(2) conical (less than three conical postcanines), gomphodont and sectorial
(3) gomphodont only (Gaetano & Abdala, 2015; #44)

30) Upper postcanines, long axis of mid-gomphodont teeth (**New**):

(0) roughly perpendicular to the long axis of the cranial tooth row
(1) diagonally and labiodistally (or linguomesially) oriented from the long axis of the cranial tooth row
(2) diagonally and labiomesially (or linguodistally) oriented from the long axis of the cranial tooth row
(3) parallel to the long axis of the cranial tooth row

31) Upper postcanines, number of subcircular alveoli/crowns with a subcircular cross-section in the mesial portion of the tooth row (**New**; ORDERED):
(0) more than two
(1) one or two
(2) absent

32) Upper postcanines, one or several sectorial teeth in the mesial portion of the tooth row (**New**):
(0) present
(1) absent

33) Upper postcanines, overall morphology of gomphodont teeth in occlusal view (Gaetano & Abdala, 2015; #45):
(0) ovoid-ellipsoid
(1) nearly rectangular
(2) nearly triangular
(3) nearly quadrangular or polygonal

34) Upper postcanines, elongation ratio (labiolingual length/mesiodistal width) of widest upper gomphodont postcanine (**New**; ORDERED):
(0) <1.4
(1) 1.4-1.8
(2) >1.8

35) Upper postcanines, distal inclination of the last gomphodont teeth in relation to the axis of the skull (Gaetano & Abdala, 2015; #30):
(0) absent or weak
(1) oblique

36) Upper postcanines, imbrication (different of shouldering) of the mesial margin in mesial gomphodont postcanines (Gaetano & Abdala, 2015; #48; ORDERED):
(0) absent
(1) slightly developed, only the mesiocentral part of the crown is imbricated
(2) well-developed, most of the crown mesial margin is imbricated (shouldering)

37) Upper postcanines, imbrication (different of shouldering) of the mesial margin in distal gomphodont postcanines (Gaetano & Abdala, 2015; #48; ORDERED):
(0) absent
(1) slightly developed, only the mesiocentral part of the crown is imbricated
(2) well-developed, most of the crown mesial margin is imbricated (shouldering)

38) Upper postcanines, strong lingual inclination of labial margin of gomphodont teeth (**New**):
(0) absent, labial surface straight or only weakly inclined lingually
(1) present, labial margin strongly inclined lingually

39) Upper postcanines, transverse symmetry of the labial and lingual halves of largest gomphodont teeth (**New**):

(0) sub-symmetrical, the labial and lingual halves of the crown have the same mesiodistal length
(1) asymmetrical, the lingual half of the crown is significantly mesiodistally longer than the labial half
(2) asymmetrical, the labial half of the crown is significantly mesiodistally longer than the lingual half

40) Upper postcanines, apicobasal groove(s) on the labial surface of some gomphodont teeth (**New**):

(0) absent
(1) present, no more than a single groove
(2) present, two grooves

41) Upper postcanines, apicobasal groove(s) on the labial surface of some gomphodont teeth (**New**):

(0) distal to labial cusp
(1) mesial to labial cusp
(2) mesial and distal to labial cusp

Extension

42) Upper postcanines, extension in labial view (**New**; ORDERED):

(0) anterior to orbit
(1) below anterior half of orbit
(2) below posterior part of orbit or posterior to orbit

43) Upper postcanines, extension of distalmost margin of tooth relative to anteriormost margin of the subtemporal fossa in palatal view (Gaetano & Abdala, 2015; #32; ORDERED):

(0) anterior
(1) at the same level
(2) posterior

44) Long axis of distal part of upper postcanine row in palatal view (Gaetano & Abdala, 2015; #31; ORDERED):

(0) directed towards the lateral part of the subtemporal fossa
(1) directed towards the center of the subtemporal fossa
(2) directed towards the medial part of the subtemporal fossa

Transverse crest

45) Position of transverse crest on upper gomphodont postcanines (Gaetano & Abdala, 2015; #54; ORDERED):

(0) on the mesial half of crown
(1) on the central part of crown
(2) on the distal half of the crown

46) Transverse crest in upper gomphodont postcanines (**New**):

(0) low ridge
(1) high crest

47) Transverse crest, morphology in upper gomphodont postcanines (**New**):

(0) smooth ridge
(1) showing some serrated portions
(2) bearing one or several distinct central accessory cusps (cuspidated)

48) Transverse crest, one or several accessory ridges on the mesial/distal surface of the crest in some upper gomphodont postcanines (**New**):

(0) present
(1) absent

49) Transverse crest, deep valleys between labial and central/lingual cusp in upper gomphodont postcanines (**New**):

(0) absent
(1) present, basal extension at the same level or close to the level of occlusal basins, well-separated cusps
(2) present, basal extension significantly higher than the occlusal basins

50) Transverse crest, deep labial valley between labial and central/lingual cusp in upper gomphodont postcanines (**New**):

(0) labiolingually narrow, less than one-third of the labiolingual length of crown
(1) labiolingually wide, more than one-third of the labiolingual length of crown

Cusp

51) Widest cusp labiolingually in transverse crest of unworn upper gomphodont postcanines (**New**):

(0) central
(1) labial
(2) lingual

52) Height of the labial and lingual cusps in unworn upper gomphodont postcanines (**New**; ORDERED):

(0) labial higher than lingual
(1) labial as high as lingual
(2) labial lower than lingual

53) Number of cusps in the transverse crest of unworn upper gomphodont postcanines (Gaetano & Abdala, 2015; #50):

(0) three or more
(1) two, central cusp merged with lingual cusp

54) Central cusp of transverse crest in upper gomphodont postcanines (Gaetano & Abdala, 2015; #51):

(0) midway between labial and lingual cusps
(1) closer to lingual cusp

55) Labial cusp, strong labial displacement from the rest of the crown in some upper gomphodont postcanines in apical view (Gaetano & Abdala, 2015; #49):

(0) absent or weak, labial surface of crown roughly convex
(1) present, labiomesial part of crown strongly protruding labially and subtriangular in apical view

56) Labiomesial accessory cusp on unworn upper postcanines (Gaetano & Abdala, 2015; #52):
- (0) absent
- (1) one
- (2) two or more

57) Labiomesial accessory cusp on unworn upper postcanines (**New**):
- (0) small, significantly smaller than main labial and lingual cusp
- (1) large, as wide or almost as wide as main labial cusp

58) Labiodistal accessory cusp on unworn upper postcanines (Gaetano & Abdala, 2015; #53):
- (0) present
- (1) absent

59) Linguomesial accessory cusp on unworn upper postcanines (Gaetano & Abdala, 2015; #55):
- (0) absent
- (1) present

Cingulum/ridge

60) Mesial cingulum/ridge on unworn upper gomphodont postcanines (Gaetano & Abdala, 2015; #56):
- (0) present, bearing distinct cuspules (cuspidated)
- (1) present, no cuspules
- (2) absent

61) Mesial cingulum/ridge on unworn upper gomphodont postcanines (Gaetano & Abdala, 2015; #57):
- (0) low ridge
- (1) high and well-developed crest

62) Distal cingulum/ridge on unworn upper gomphodont postcanines (Gaetano & Abdala, 2015; #47):
- (0) present, bearing distinct cuspules (cuspidated)
- (1) present, serrated
- (2) present, smooth ridge
- (3) absent

63) Labial cingulum on mesial portion of upper gomphodont postcanines, labial to the labial cusp (Gaetano & Abdala, 2015; #46):
- (0) absent
- (1) present, serrated
- (2) present, smooth ridge

64) Lingual ridge on upper gomphodont postcanines (Gaetano & Abdala, 2015; #58):
- (0) absent
- (1) present, low
- (2) present, high

65) Central ridge mesial and parallel to transverse crest on some upper gomphodont postcanines (**New**):
- (0) absent
- (1) present

Basin

66) Mesial basin on upper gomphodont postcanines (**New**):
- (0) present, mesiodistally narrow, forming a labiodistally extended groove
- (1) present, mesiodistally wide surface
- (2) absent

67) Mesial basin on upper gomphodont postcanines (**New**):
- (0) sloping towards the mesial side of the crown
- (1) converging towards the labiomesial side of the crown, deepest portion of the mesial basin situated labiomesially
- (2) converging towards the linguomesial side of the crown, deepest portion of the mesial basin situated linguomesially

68) Distal basin on upper gomphodont postcanines (**New**):
- (0) present
- (1) absent

V. LOWER POSTCANINES

69) Lower postcanines, number (**New**):
- (0) 11 or more
- (1) less than 11

70) Lower postcanines, covering by coronoid process of the mandible in labial/lingual view (Gaetano & Abdala, 2015; #33):
- (0) coronoid process covers entirely the distalmost postcanine
- (1) coronoid process does not cover entirely the distalmost postcanine

71) Lower postcanines, overall morphology of gomphodont teeth in occlusal view (Gaetano & Abdala, 2015; #59):
- (0) circular
- (1) ovoid-ellipsoid
- (2) quadrangular or subrectangular
- (3) subtriangular

72) Lower postcanines, elongation ratio (labiolingual length/mesiodistal width) of most labiolingually elongated lower gomphodont postcanine (**New**; ORDERED):
- (0) >1.5
- (1) 1.1-1.5
- (2) <1.1

73) Lower postcanines, long axis of gomphodont tooth in apical view (**New**):
- (0) perpendicular to the long axis of the mandibular tooth row
- (1) strongly diagonally oriented from the long axis of the mandibular tooth row
- (2) parallel to the long axis of the mandibular tooth row

74) Lower postcanines, distal inclination of mesial teeth from the main axis of the alveolar margin in labial view (**New**):
- (0) absent, tooth nearly vertical
- (1) present, slightly inclined distally
- (2) present, strongly inclined distally

75) Lower postcanines, labiolingual constriction in the transversal plane of distal gomphodont teeth at mid-crown in apical view (**New**):

(0) absent
(1) weak
(2) important

Crest

76) Transverse crest in lower gomphodont postcanines (Gaetano & Abdala, 2015; #60):

(0) central
(1) mesial

77) Transverse crest in lower gomphodont postcanines, valley between labial and central/lingual cusps (**New**):

(0) absent or shallow
(1) present and deep

78) Labial ridge/crest in unworn lower gomphodont postcanines (**New**):

(0) absent
(1) present, smooth ridge
(2) present, crenulated crest/cingulum

Cusp

79) Number of cusps in the transverse crest of the unworn lower gomphodont postcanines (Gaetano & Abdala, 2015; #61):

(0) two
(1) three or more

80) Central cusp of transverse crest in lower gomphodont postcanines (**New**):

(0) midway between labial and lingual cusps
(1) closer to lingual cusp
(2) closer to labial cusp

81) Height of the labial and lingual cusps in the lower gomphodont postcanines (Gaetano & Abdala, 2015; #64):

(0) labial lower than lingual
(1) labial as high as lingual
(2) labial higher than lingual

82) Widest cusp labiolingually in transverse crest of unworn lower gomphodont postcanines (Gaetano & Abdala, 2015; #65):

(0) lingual
(1) labial
(2) central
(3) lingual and labial of same size

83) Lower postcanines, strong distal inclination of lingual cusp from labial cusp in distalmost gomphodont teeth in lingual view (Gaetano & Abdala, 2015; #66):

(0) absent, main axis of lingual and labial cusps subparallel
(1) present, lingual cusp strongly distally inclined from labial cusp

84) Labiomesial accessory cusp on unworn lower gomphodont postcanines (**New**):

(0) present
(1) absent

85) Linguomesial accessory cusp on unworn lower gomphodont postcanines (**New**):
(0) present
(1) absent

86) Labiodistal accessory cusp on unworn lower gomphodont postcanines (**New**):
(0) present
(1) absent

87) Linguodistal accessory cusp on unworn lower gomphodont postcanines (**New**):
(0) present
(1) absent

Cingulum

88) Mesial cingulum in unworn lower gomphodont postcanines (Gaetano & Abdala, 2015; #62):
(0) disposed along the entire mesial margin of the crown
(1) reduced, cingulum centrally or labially positioned on the mesial margin of the crown
(2) absent

89) Mesial cingulum in unworn lower gomphodont postcanines (**New**):
(0) separated from the transverse crest by a mesial basin
(1) directly adjacent to transverse crest

90) Distal cingulum/ridge on unworn lower gomphodont postcanines (Gaetano & Abdala, 2015; #63):
(0) present, serrated or bearing distinct cuspules (cuspidated)
(1) present, smooth ridge
(2) absent

91) Distal cingulum/ridge on unworn lower gomphodont postcanines (**New**):
(0) low ridge
(1) high crest

IV. SECTORIAL POSTCANINES

92) Upper/Lower sectorial postcanines (intermediate postcanine included), number (**New**):
(0) more than 3
(1) two or three
(2) one

93) Sectorial postcanines, intermediate gomphodont/sectorial tooth (**New**):
(0) absent
(1) present

94) Sectorial postcanines, elongation axis of upper teeth (**New**):
(0) roughly parallel to the labial margin of the cranium or aligned with the main axis of the upper tooth row
(1) strongly diagonally and mesiolingually oriented from the labial margin of the cranium and the main axis of the upper tooth row

95) Sectorial postcanines, main cusp in most teeth (**New**):
- (0) strongly distally recurved, tip pointing almost distally, extending above the distal main cusp
- (1) poorly distally recurved, tip pointing slightly apicodistally and not extending above the distal main cusp
- (2) straight

96) Sectorial postcanines, main cusp in most teeth (**New**):
- (0) large, occupies more than half the sectorial crown length
- (1) medium-sized, occupies one half of sectorial crown length
- (2) small, occupies less than a half of sectorial crown length

97) Sectorial postcanines, mesial main cusp in some teeth (**New**):
- (0) present
- (1) absent

98) Sectorial postcanines, mesial main cusp in most teeth (**New**):
- (0) large, strongly protruding from sectorial crown
- (1) reduced in size, but not forming a crenulated ridge
- (2) reduced in size, and forming a crenulated ridge with the mesial accessory cusps of similar size

99) Sectorial postcanines, highest number of mesial accessory cusp(s) mesial to the mesial main cusp (**New**):
- (0) present, more than one mesial accessory cusps
- (1) present, a single mesial accessory cusp
- (2) absent

100) Sectorial postcanines, distal main cusp in at least some teeth (**New**):
- (0) present
- (1) absent
- (3) absent

101) Sectorial postcanines, highest number of distal accessory cusp(s) distal to the mesial main cusp (**New**):
- (0) present, more than one distal accessory cusps
- (1) present, a single distal accessory cusp
- (2) absent

102) Sectorial postcanines, distal accessory cusp in most teeth (**New**):
- (0) large, strongly protruding from sectorial crown
- (1) reduced in size, but not forming a crenulated ridge
- (2) reduced in size, and forming a crenulated ridge with the mesial accessory cusps of similar size

103) Sectorial postcanines, serrations on the mesial carina in some teeth (**New**):
- (0) present on most of the crown height
- (1) present on the apical part of the crown
- (2) absent

104) Sectorial postcanines, shape of mesial denticles (**New**):
- (0) convex

(1) biserrated, with a small basal denticle and a larger distal denticle

105) Sectorial postcanines, cingulum/cingular cusps in some teeth (**New**):
(0) absent
(1) present lingually
(2) present labially
(3) present both lingually and labially

106) Sectorial postcanines, labial cingulum in some upper postcanines (**New**):
(0) well-developed multicuspid cingulum forming a collar
(1) non-cuspidate ridge not forming a collar
(2) one or two cingular cusps

107) Sectorial postcanines, lingual cingulum in some lower postcanines (**New**):
(0) well-developed multicuspid cingulum forming a collar
(1) poorly developed multicuspid cingulum not forming a collar
(2) one or two cingular cusps

VI. OCCLUSION

108) Postcanine occlusion (Gaetano & Abdala, 2015; #34):
(0) absent
(1) present

109) Deep occlusal basins in the postcanines (Gaetano & Abdala, 2015; #67):
(0) absent
(1) present

110) Shearing planes between the outer surface of the main cusp of the lower and the inner surfaces of the main cusps of the upper postcanines (Gaetano & Abdala, 2015; #35):
(0) present
(1) absent

VII. TEXTURE

111) Braided and oriented enamel surface texture in some incisors/canines (**New**):
(0) absent, enamel texture of all incisors/canines smooth or irregular and non-oriented
(1) present

112) braided and oriented enamel surface texture in some postcanines (**New**):
(0) absent, enamel texture of all postcanines smooth or irregular and non-oriented
(1) present

VIII. ROOT

113) Lower postcanines, horizontal labiolingual constriction between crown and root in mesial/distal view (**New**):
(0) absent or weak, crown and root (almost) confluent
(1) important, strong constriction between crown and root

114) Postcanine root, length (**New**):
(0) long, more than twice the largest crown height
(1) short, less than twice the crown height

IX. NON-DENTAL CRANIAL CHARACTERS

115) Adult maximum skull size (Gaetano & Abdala, 2015; #1):
- (0) large (greater than 25 cm)
- (1) medium to small

116) Snout (preorbit) in adults in relation to temporal region (Gaetano & Abdala, 2015; #2):
- (0) longer
- (1) subequal
- (2) shorter

117) Two side of temporal fenestra (outline of zygoma) (Gaetano & Abdala, 2015; #3):
- (0) divergent posteriorly
- (1) nearly parallel
- (2) bulge in the middle

118) Extranasal process of the premaxilla (**New**):
- (0) small
- (1) large but not contacting the nasal

119) Septomaxilla facial process (**New**):
- (0) long
- (1) short

120) Carotid artery foramina in basisphenoid (**New**):
- (0) present
- (1) absent

121) Mandibular symphysis (**New**):
- (0) unfused
- (1) fused

122) Zygomatic arch dorsoventral height (**New**):
- (0) moderately deep
- (1) very deep

123) Inferior margin of jugal in the zygoma (**New**):
- (0) low
- (1) high

124) Premaxilla forms posterior border incisive foramen (Gaetano & Abdala, 2015; #4):
- (0) absent
- (1) present

125) Vomer exposure in incisive foramen (at anterior ends of maxillae on palate) (Gaetano & Abdala, 2015; #5):
- (0) present
- (1) absent

126) Vomer vertical septum extending posteriorly beyond level of secondary palate (Gaetano & Abdala, 2015; #6):
- (0) present
- (1) absent

127) Internarial bar (Gaetano & Abdala, 2015; #7):
(0) present
(1) absent

128) Parietal foramen in adults (Gaetano & Abdala, 2015; #8):
(0) present
(1) absent

129) Ectopterygoid (Gaetano & Abdala, 2015; #9):
(0) present
(1) absent

130) Posterior extension of secondary palate relative to anterior border of orbit (Gaetano & Abdala, 2015; #10, Modified):
(0) anterior
(1) subequal
(2) posterior

131) Posterior extension of the jugal dorsally above the squamosal in the zygomatic arch (Gaetano & Abdala, 2015; #11):
(0) absent or with small extension
(1) well developed

132) Position of anterior root of the zygomatic arch relative to the ventral margin of the maxilla (Gaetano & Abdala, 2015; #12):
(0) nearly at same level or slightly higher
(1) remarkably higher

133) Zygomatic process of the jugal (Gaetano & Abdala, 2015; #13):
(0) little projected
(1) conspicuously projected
(2) absent
(3) a ball-like process

134) Diameter of suborbital bar below center of orbit (anterior to suborbital process, where present) (Gaetano & Abdala, 2015; #14):
(0) greater than 1/2 diameter of bar below posterior part of orbit (posterior to suborbital process)
(1) less than 1/2 diameter of bar below posterior part of orbit

135) Maxilla in the margin of the subtemporal fenestra (Gaetano & Abdala, 2015; #15):
(0) excluded
(1) included

136) Epipterygoid-quadrate contact (Gaetano & Abdala, 2015; #16):
(0) present
(1) absent

137) Frontal-epipterygoid contact (Gaetano & Abdala, 2015; #17):
(0) present
(1) absent

138) Palatine (Gaetano & Abdala, 2015; #18):

(0) does not meet frontal
(1) meets frontal but neither element contributes significantly to medial orbit wall

139) Notch separating lambdoidal crest from zygomatic arch (Gaetano & Abdala, 2015; #19):
(0) shallow
(1) deep v-shaped

140) Lower jaw symphysis as a chin-like process in adults (Gaetano & Abdala, 2015; #20):
(0) absent or little developed
(1) well-developed

141) Dentary with sigmoid ventral curvature (Gaetano & Abdala, 2015; #21):
(0) absent
(1) present

142) Dentary angular process (Gaetano & Abdala, 2015; #22):
(0) not or very weakly projected posteriorly
(1) projected posteriorly as distinct process

143) Elongated mental foramen below postcanine tooth row and above coronoid ridge (Gaetano & Abdala, 2015; #23):
(0) absent
(1) present

144) Coronoid ridge anterior to masseteric fossa (Gaetano & Abdala, 2015; #24):
(0) absent to low
(1) very strong, outturned

145) Maxillary labial platform lateral to the postcanine series (Gaetano & Abdala, 2015; #29):
(0) absent
(1) present

X POSTCRANIAL CHARACTERS

146) Anapophysis (Gaetano & Abdala, 2015; #68):
(0) absent
(1) present

147) Expanded costal plates on ribs (Gaetano & Abdala, 2015; #69):
(0) present
(1) absent

148) Lumbar costal plates with ridge overlapping preceding rib (Gaetano & Abdala, 2015; #70):
(0) present
(1) absent

149) Procoracoid in glenoid (Gaetano & Abdala, 2015; #71):
(0) present
(1) barely present or absent

150) Dorsal margin of the coracoid in medial view related to that of the procoracoid (Gaetano & Abdala, 2015; #72):
(0) shorter
(1) equal or longer

151) Cranial margin of the procoracoid (Gaetano & Abdala, 2015; #73):
(0) convex
(1) nearly straight
(2) obviously concave

152) Angle between ventral margin on anterior and posterior process of iliac blade (Gaetano & Abdala, 2015; #74):
(0) small (e.g., less than 140 degree)
(1) large

153) Length of anterior process of ilium anterior to acetabulum (relative to diameter of acetabulum) (Gaetano & Abdala, 2015; #75):
(0) less than 1.5
(1) greater than 1.5

154) Dorsal profile of ilium (Gaetano & Abdala, 2015; #76):
(0) convex
(1) flat or concave

155) The trochanter major position related to the femoral head (Gaetano & Abdala, 2015; #77):
(0) distal
(1) close, major part in same height

156) Major palatine foramen (Gaetano & Abdala, 2015; #78):
(0) at axillary/palatine suture
(1) penetrating palatine

157) Number of crurae (Gaetano & Abdala, 2015; #79):
(0) one
(1) two

158) Curvature of the crurae (Gaetano & Abdala, 2015; #80):
(0) both crurae straight
(1) both crurae curved
(2) posterior crus curved, anterior crus straight

159) Relative size of the stapedial foramen (Gaetano & Abdala, 2015; #81):
(0) large, aprox 3/4 of the total length of the stapes
(1) medium-sized, aprox 2/3 of the total length of the stapes
(2) small, aprox 1/2 of the total length of the stapes

160) Ossified portion of the stapes medial and lateral to the stapedial foramen (Gaetano & Abdala, 2015; #82):
(0) medial and lateral ossified sectors restricted to the fusion of the crurae
(1) medial ossified sector constituting a platform
(2) lateral ossified sector constituting a platform

161) Relative size of the ossified portion of the stapes medial and lateral to the stapedial foramen (Gaetano & Abdala, 2015; #83):
(0) medial portion wider than the lateral one
(1) lateral platform wider than the medial one
(2) medial portion as wide as the lateral one

162) Ossified dorsal process of the stapes (Gaetano & Abdala, 2015; #84):
(0) present
(1) absent

163) Anterior projection of the medial margin of the stapes in ventral view (Gaetano & Abdala, 2015; #85):
(0) absent
(1) present

164) Posterior projection of the medial margin of the stapes in ventral view (Gaetano & Abdala, 2015; #86):
(0) absent
(1) present

165) Anterior projection of the lateral margin of the stapes in ventral view (Gaetano & Abdala, 2015; #87):
(0) absent
(1) present

166) Posterior projection of the lateral margin of the stapes in ventral view (Gaetano & Abdala, 2015; #88):
(0) absent
(1) present

167) Stapedial footplate expanded dorsoventrally (Gaetano & Abdala, 2015; #89):
(0) absent
(1) present

168) Stapes length relative to the skull basal length (Gaetano & Abdala, 2015; #90):
(0) greater than 7%
(1) less than 5.5%

169) Anteriorly projected process that contacts the anapophyses in the cervical vertebrae (**New**):
(0) absent
(1) present

170) Intercentra in the cervical postaxial region (**New**):
(0) absent
(1) present

171) Inflated anterior and posterior margins of the cervical centra in lateral view (**New**):
(0) not inflated or only slightly inflated
(1) very inflated, bulbous

3. Phylogenetic analysis on our dataset

3.1 Files

The Excel, Mesquite and TNT files are downloadable at https://drive.google.com/drive/folders/1jD5S1h0r45rTNGYxXTPg0EnZVcx8ISQ1?usp=sharing and can be obtained by request to the corresponding author.

3.2 Data matrix

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Menadon_Madagascar 012--1121111000-11101110100232211101000111012001111l1-
1101111302111l102??2?1010-??0??1?2-??----------
11000??10100?11111?01?011210???10110010l?1?0111??10000?010100011
Menadon_Brazil 012--102?10102--0111?110000?33213001000110012001111l1-1101110302011111222201010-
1?011112-10----------11000?010100?11011?01?011210???10110010l?1?0111??10000?010100???
Protuberum 002--01111???2--0?221???000?322111020000-1212[0 1]01[0 1]12[0 2]1-00010103020[1
2]01???11000?110110111O?111011111111??1?????110?????????????????
???001
Ruberodon 0?????????110????????[0 1]???10222201010-
21011112-?????????????????????110?0??0?????1?????????????????01101?????????????????????????
Scalenodontoides002--001111102--01220110100?32211202200222222001O-101-00-0?10301011111222211010-
21111112-10----------11001?1012???110???11?111?11???11?1001?????????????????????????
Exaeretodon_argentinus 002--001111102--1122011[0 1]10023221120221222222210111101-
11001113010111102222[0 1]1010-21111112-10----------
11011?1000101110111111111111?1101100101?1?11111013000l1001100000
Exaeretodon_riograndensis 012--001111102--0122011?1002322112022[0 1]222222210111[1 2]01-10-
01113010111102222110l0-21111112-10----------
11001??000001110111111111111??101100101?????1110??????????????
Siriusgnathus [0 1]12--?[0 1]0111[0 1]02--??22[0 1]1??100?322112122122122[1 2]2?0111101-110011130[0
1]011102222?1010-21111112-10----------
110????0?0001110?111112110111??1011001?????????????????????????

Habayia ??????????????????????????????????00???020-???110111221-011102-
3000000??11??0??1??
??????
Maubeugia
??31??01001220001112-2-
??????????????????11??011??
Rosieria ??????????????????????????????????12???000-???11010-221-010102-
3000000??11??0??1??
??????
Microscalenodon ??????????????????????????????????12???020-???20010-221-00-102-3000000??32??11100-
010110?2-10??????????????????110?0??1??
;

cnames
{0 Incisors,_cross-section_of_mesialmost_incisors_at_mid-crown: salinon_or_D-shaped_
subcircular,_ovoid,_lanceolate_or_thick_lenticular parlinon-shaped_or_narrow_lenticular;
{1 Incisors,_constriction_at_the_crown_base_in_some_teeth: absent present,_weak
present,_important_(=_folidont_teeth);
{2 Incisors,_denticles: present_and_small,_more_than_20_mesial/distal_denticles_along_the_crown_height
present_and_large,_less_than_20_mesial/distal_denticles_along_the_crown_height absent;
{3 Incisors,_denticles: present_on_the_mesial_and_distal_carinae present_on_the_distal_carina_only;
{4 Incisors,_denticle_orientation: perpendicular_to_carina diagonally_oriented;
{5 Incisors,_numerous_longitudinal_ridges_on_labial_surface_in_some_teeth: absent present;
{6 Upper_incisors,_crown_base_length_(CBL)_in_adults: small,_CBL_shorter_than_that_of_canines
enlarged,_CBL_of_incisors_as_long_or_longer_than_that_of_canines;
{7 Upper_incisors,_number: two three four five;
{8 Upper_incisors,_procumbency: absent_or_very_light present,_strongly_procumbent_teeth
present,_only_first_incisor_procumbent;
{9 Upper_incisors,_diastema_before_upper_canines: present,_longer_than_the_last_upper_incisor_CBL
absent_or_short,_shorter_than_the_last_upper_incisor_CBL;
{10 Lower_incisors,_CBL_in_adults: small,_CBL_shorter_than_that_of_canines
enlarged,_CBL_of_incisors_as_long_or_longer_than_that_of_canines;
{11 Lower_incisors,_number: two three four;
{12 Lower_incisors,_procumbency: present absent_or_very_light;
{13 Canines,_denticles: present,_more_than_15_denticles_per_5_mm_along_the_distal_carina
present,_15_or_less_denticles_per_5_mm_along_the_distal_carina absent;
{14 Canines,_denticle_size_along_the_carina: regular,_gradual_change_in_denticle_size
irregular,_sporadic_change_in_denticle_size;
{15 Canines,_mesial_denticles_significantly_larger_than_distal_denticles_(DSDI>1.2)_in_adults_: absent present;
{16 Canine,_longitudinal_ridges_on_some_crowns: absent present,_poorly_defined_ridges present,_well-
delimited_ridges;
{17 Canine,_transverse_undulations_in_adults: present absent;
{18 Upper_canines,_position_in_relation_to_paracanine_fossa: labiodistal labial labiomesial;
{19 Upper_canines,_diastema_before_upper_postcanines_in_adults:
short,_less_than_the_mesiodistal_length_of_the_upper_canine_alveoli_
medium,_more_than_the_mesiodistal_length_of_the_upper_canine_alveoli_but_less_than_twice_this_length
long,_more_than_twice_the_mesiodistal_length_of_the_upper_canine_alveoli;
{20 Upper_canines,_size_in_adult: large,_upper_canine_height_more_than_twice_the_upper_incisor_height
reduced_in_size,_upper_canine_height_less_than_twice_upper_incisor's_height upper_canine_absent;
{21 Lower_canines,_diastema_before_lower_postcanines_in_adults: long,_longer_than_the_lower_canine_CBL
absent_or_short,_shorter_than_the_lower_canine_CBL;
{22 Lower_canines,_size: large,_lower_canine_height_more_than_twice_the_lower_incisor_height
reduced_in_size,_lower_canine_height_less_than_twice_the_lower_incisor_height lower_canine_absent;
{23 Lower_canines,_procumbency: absent,_crown_apex_projecting_dorsally
present,_crown_apex_projecting_mesiodorsally;
{24 Paracanine_fossa_in_cranium: deep_and_well_delimited shallow_and_poorly_delimited;

{25 Paracanine_fossa_in_cranium: mesiodistally_longer_than_mesiodistal_length_of_upper_canine_alveoli
same_mesiodistal_length_or_shorter_than_mesiodistal_length_of_upper_canine_alveoli;
{26 Upper_postcanines,_number: 11_or_less more_than_11;
{27 Upper_postcanines,_variation_in_the_number_of_teeth_during_ontogeny:
number_of_teeth_remaining_stable_during_ontogeny number_of_teeth_increasing_during_growth
number_of_teeth_decreasing_during_growth;
{28 Upper/lower_postcanines,_formed_by: sectorial_only
conical_(more_than_two_conical_postcanines),_gomphodont_and_sectorial
conical_(less_than_three_conical_postcanines),_gomphodont_and_sectorial_ gomphodont_only;
{29 Upper_postcanines,_long_axis_of_mid-gomphodont_teeth:
roughly_perpendicular_to_the_long_axis_of_the_cranial_tooth_row
diagonally_and_labiodistally_(or_linguomesially)_oriented_from_the_long_axis_of_the_cranial_tooth_row
diagonally_and_labiomesially_(or_linguodistally)_oriented_from_the_long_axis_of_the_cranial_tooth_row
parallel_to_the_long_axis_of_the_cranial_tooth_row;
{30 Upper_postcanines,_number_of_subcircular_alveoli/_crowns_with_a_subcircular_cross-
section_in_the_mesial_portion_of_the_tooth_row: more_than_two one_or_two absent;
{31 Upper_postcanines,_one_or_several_sectorial_teeth_in_the_mesial_portion_of_the_tooth_row: present absent;
{32 Upper_postcanines,_overall_morphology_of_gomphodont_teeth_in_occlusal_view: ovoid-ellipsoid
nearly_rectangular nearly_triangular nearly_quadrangular_or_polygonal;
{33
Upper_postcanines,_elongation_ratio_(labiolingual_length/mesiodistal_width)_of_widest_upper_gomphodont_postc
anine: <1.4 1.4-1.8 >1.8;
{34 Upper_postcanines,_distal_inclination_of_the_last_gomphodont_teeth_in_relation_to_the_axis_of_the_skull:
absent_or_weak oblique;
{35
Upper_postcanines,_imbrication_(different_of_shouldering)_of_the_mesial_margin_in_mesial_gomphodont_postca
nines: absent slightly_developed,_only_the_mesiocentral_part_of_the_crown_is_imbricated well-
developed,_most_of_the_crown_mesial_margin_is_imbricated_(shouldering);
{36
Upper_postcanines,_imbrication_(different_of_shouldering)_of_the_mesial_margin_in_distal_gomphodont__postca
nines: absent slightly_developed,_only_the_mesiocentral_part_of_the_crown_is_imbricated well-
developed,_most_of_the_crown_mesial_margin_is_imbricated_(shouldering);
{37 Upper_postcanines,_strong_lingual_inclination_of_labial_margin_of_gomphodont_teeth:
absent,_labial_surface_straight_or_only_weakly_inclined_lingually
present,_labial_margin_strongly_inclined_lingually;
{38 Upper_postcanines,_transverse_symmetry_of_the_labial_and_lingual_halves_of_largest_gomphodont_teeth:
sub-symmetrical,_the_labial_and_lingual_halves_of_the_crown_have_the_same_mesiodistal_length
asymmetrical,_the_lingual_half_of_the_crown_is_significantly_mesiodistally_longer_than_the_labial_half_
asymmetrical,_the_labial_half_of_the_crown_is_significantly_mesiodistally_longer_than_the_lingual_half_;
{39 Upper_postcanines,_apicobasal_groove(s)_on_the_labial_surface_of_some_gomphodont_teeth: absent
present,_no_more_than_a_single_groove present,_two_grooves;
{40 Upper_postcanines,_apicobasal_groove(s)_on_the_labial_surface_of_some_gomphodont_teeth
distal_to_labial_cusp mesial_to_labial_cusp mesial_and_distal_to_labial_cusp;
{41 Upper_postcanines,_extension_in_labial_view: anterior_to_orbit below_anterior_half_of_orbit
below_posterior_part_of_orbit_or_posterior_to_orbit;
{42
Upper_postcanines,_extension_of_distalmost_margin_of_tooth_relative_to_anteriormost_margin_of_the_subtempor
al_fossa_in_palatal_view: anterior at_the_same_level posterior;
{43 Long_axis_of_distal_part_of_upper_postcanine_row_in_palatal_view:
directed_towards_the_lateral_part_of_the_subtemporal_fossa
directed_towards_the_center_of_the_subtemporal_fossa
directed_towards_the_medial_part_of_the_subtemporal_fossa;
{44 Position_of_transverse_crest_on_upper_gomphodont_postcanines: on_the_mesial_half_of_crown
on_the_central_part_of_crown on_the_distal_half_of_the_crown;
{45 Transverse_crest_in_upper_gomphodont_postcanines: low_ridge high_crest;

{46 Transverse_crest,_morphology_in_upper_gomphodont_postcanines: smooth_ridge
showing_some_serrated_portions bearing_one_or_several_distinct_central_accessory_cusps_(cuspidated);
{47
Transverse_crest,_one_or_several_accessory_ridges_on_the_mesial/distal_surface_of_the_crest_in_some_upper_go
mphodont_postcanines present absent;
{48
Transverse_crest,_deep_labial_valley_between_labial_and_central/lingual_cusp_in_upper_gomphodont_postcanines
: absent present,_basal_extension_at_the_same_level_or_close_to_the_level_of_occlusal_basins,_well-
separated_cusps present,_basal_extension_significantly_higher_than_the_occlusal_basins;
{49
Transverse_crest,_deep_labial_valley_between_labial_and_central/lingual_cusp_in_upper_gomphodont__postcanin
es: labiolingually_narrow,_less_than_one-third_of_the_labiolingual_length_of_crown
labiolingually_wide,_more_than_one-third_of_the_labiolingual_length_of_crown;
{50 Widest_cusp_labiolingually_in_transverse_crest_of_unworn_upper_gomphodont_postcanines: central labial
lingual;
{51 Height_of_the_labial_and_lingual_cusps_in_unworn_upper_gomphodont_postcanines:
labial_higher_than_lingual labial_as_high_as_lingual labial_lower_than_lingual;
{52 Number_of_cusps_in_the_transverse_crest_of_unworn_upper_gomphodont_postcanines: three_or_more
two,_central_cusp_merged_with_lingual_cusp;
{53 Central_cusp_of_transverse_crest_in_upper_gomphodont_postcanines:
midway_between_labial_and_lingual_cusps closer_to_lingual_cusp;
{54
Labial_cusp,_strong_labial_displacement_from_the_rest_of_the_crown_in_some_upper_gomphodont_postcanines_i
n_apical_view: absent_or_weak,_labial_surface_of_crown_roughly_convex
present,_labiomesial_part_of_crown_strongly_protruding_labially_and_subtriangular_in_apical_view;
{55 Labiomesial_accessory_cusp_on_unworn_upper_postcanines: absent one two_or_more;
{56 Labiomesial_accessory_cusp_on_unworn_upper_postcanines:
small,_significantly_smaller_than_main_labial_and_lingual_cusp
large,_as_wide_or_almost_as_wide_as_main_labial_cusp;
{57 Labiodistal_accessory_cusp_on_unworn_upper_postcanines: present absent;
{58 Linguomesial_accessory_cusp_on_unworn_upper_postcanines: absent present;
{59 Mesial_cingulum/ridge_on_unworn_upper_gomphodont_postcanines:
present,_bearing_distinct_cuspules_(cuspidated) present,_no_cuspules absent;
{60 Mesial_cingulum/ridge_on_unworn_upper_gomphodont_postcanines: low_ridge high_and_well-
developed_crest;
{61 Distal_cingulum/ridge_on_unworn_upper_gomphodont_postcanines:
present,_bearing_distinct_cuspules_(cuspidated) present,_serrated present,_smooth_ridge absent;
{62 Labial_cingulum_on_mesial_portion_of_upper_gomphodont_postcanines,_labial_to_the_labial_cusp: absent
present,_serrated present,_smooth_ridge;
{63 Lingual_ridge_on_upper_gomphodont_postcanines: absent present,_low present,_high;
{64 Central_ridge_mesial_and_parallel_to_transverse_crest_on_some_upper_gomphodont_postcanines: absent
present;
{65 Mesial_basin_on_upper_gomphodont_postcanines:
present,_mesiodistally_narrow,_forming_a_labiodistally_extended_groove present,_mesiodistally_wide_surface
absent;
{66 Mesial_basin_on_upper_gomphodont_postcanines: sloping_towards_the_mesial_side_of_the_crown
converging_towards_the_labiomesial_side_of_the_crown,_deepest_portion_of_the_mesial_basin_situated_labiomes
ially
converging_towards_the_linguomesial_side_of_the_crown,_deepest_portion_of_the_mesial_basin_situated_linguo
mesially;
{67 Distal_basin_on_upper_gomphodont_postcanines: present absent;
{68 Lower_postcanines,_number: 11_or_more less_than_11;
{69 Lower_postcanines,_covering_by_coronoid_process_of_the_mandible_in_labial/lingual_view:
coronoid_process_covers_entirely_the_distalmost_postcanine
coronoid_process_does_not_cover_entirely_the_distalmost_postcanine;

{70 Lower_postcanines,_overall_morphology_of_gomphodont_teeth_in_occlusal_view: circular ovoid-ellipsoid quadrangular_or_subrectangular subtriangular;
{71
Lower_postcanines,_elongation_ratio_(labiolingual_length/mesiodistal_width)_of_most_labiolingually_elongated_lower_gomphodont_postcanine: >1.5 1.1-1.5 <1.1;
{72 Lower_postcanines,_long_axis_of_gomphodont_tooth_in_apical_view:
perpendicular_to_the_long_axis_of_the_mandibular_tooth_row
strongly_diagonally_oriented_from_the_long_axis_of_the_mandibular_tooth_row
parallel_to_the_long_axis_of_the_mandibular_tooth_row;
{73
Lower_postcanines,_distal_inclination_of_mesial_teeth_from_the_main_axis_of_the_alveolar_margin_in_labial_view: absent,_tooth_nearly_vertical present,_slightly_inclined_distally present,_strongly_inclined_distally;
{74 Lower_postcanines,_labiolingual_constriction_in_the_transversal_plane_of_distal_gomphodont_teeth_at_mid-crown_in_apical_view: absent weak important;
{75 Transverse_crest_in_lower_gomphodont_postcanines: central mesial;
{76 Transverse_crest_in_lower_gomphodont_postcanines,_valley_between_labial_and_central/lingual_cusps: absent_or_shallow present_and_deep;
{77 Labial_ridge/crest_in_unworn_lower_gomphodont_postcanines: absent present,_smooth_ridge present,_crenulated_crest/cingulum;
{78 Number_of_cusps_in_the_transverse_crest_of_the_unworn_lower_gomphodont_postcanines: two three_or_more;
{79 Central_cusp_of_transverse_crest_in_lower_gomphodont_postcanines:
midway_between_labial_and_lingual_cusps closer_to_lingual_cusp closer_to_labial_cusp;
{80 Height_of_the_labial_and_lingual_cusps_in_the_lower_gomphodont_postcanines: labial_lower_than_lingual labial_as_high_as_lingual labial_higher_than_lingual;
{81 Widest_cusp_labiolingually_in_transverse_crest_of_unworn_lower_gomphodont_postcanines: lingual labial central lingual_and_labial_of_same_size;
{82
Lower_postcanines,_strong_distal_inclination_of_lingual_cusp_from_labial_cusp_in_distalmost_gomphodont_teeth_in_lingual_view: absent,_main_axis_of_lingual_and_labial_cusps_subparallel_
present,_lingual_cusp_strongly_distally_inclined_from_labial_cusp;

{83 Labiomesial_accessory_cusp_on_unworn_lower_gomphodont_postcanines: present absent;
{84 Linguomesial_accessory_cusp_on_unworn_lower_gomphodont_postcanines: present absent;
{85 Labiodistal_accessory_cusp_on_unworn_lower_gomphodont_postcanines: present absent;
{86 Linguodistal_accessory_cusp_on_unworn_lower_gomphodont_postcanines: present absent;
{87 Mesial_cingulum_in_unworn_lower_gomphodont_postcanines:
disposed_along_the_entire_mesial_margin_of_the_crown
reduced,_cingulum_centrally_or_labially_positioned_on_the_mesial_margin_of_the_crown absent;
{88 Mesial_cingulum_in_unworn_lower_gomphodont_postcanines:
separated_from_the_transverse_crest_by_a_mesial_basin directly_adjacent_to_transverse_crest;
{89 Distal_cingulum/ridge_on_unworn_lower_gomphodont_postcanines:
present,_serrated_or_bearing_distinct_cuspules_(cuspidated) present,_smooth_ridge absent;
{90 Distal_cingulum/ridge_on_unworn_lower_gomphodont_postcanines: low_ridge high_crest;
{91 Upper/Lower_sectorial_postcanines_(intermediate_postcanine_included),_number: more_than_3 two_or_three one;
{92 Sectorial_postcanines,_intermediate_gomphodont/sectorial_tooth: absent present;
{93 Sectorial_postcanines,_elongation_axis_of_upper_teeth
roughly_parallel_to_the_labial_margin_of_the_cranium_or_aligned_with_the_main_axis_of_the_upper_tooth_row
strongly_diagonally_and_mesiolingually_oriented_from_the_labial_margin_of_the_cranium_and_the_main_axis_of_the_upper_tooth_row;
{94 Sectorial_postcanines,_main_cusp_in_most_teeth
strongly_distally_recurved,_tip_pointing_almost_distally,_extending_above_the_distal_main_cusp
poorly_distally_recurved,_tip_pointing_slightly_apicodistally_and_not_extending_above_the_distal_main_cusp
straight;

{95 Sectorial_postcanines,_main_cusp_in_most_teeth large,_occupies_more_than_half_the_sectorial_crown_length
medium-sized,_occupies_one_half_of_sectorial_crown_length
small,_occupies_less_than_a_half_of_sectorial_crown_length;
{96 Sectorial_postcanines,_mesial_main_cusp_in_some_teeth: present absent;
{97 Sectorial_postcanines,_mesial_main_cusp_in_most_teeth: large,_strongly_protruding_from_sectorial_crown
reduced_in_size,_but_not_forming_a_crenulated_ridge
reduced_in_size,_and_forming_a_crenulated_ridge_with_the_mesial_accessory_cusps_of_similar_size;

{98 Sectorial_postcanines,_highest_number_of_mesial_accessory_cusp(s)_mesial_to_the_mesial_main_cusp:
present,_more_than_one_mesial_accessory_cusps present,_a_single_mesial_accessory_cusp absent;
{99 Sectorial_postcanines,_distal_main_cusp_in_at_least_some_teeth: present absent _ absent;
{100 Sectorial_postcanines,_highest_number_of_distal_accessory_cusp(s)_distal_to_the_mesial_main_cusp:
present,_more_than_one_distal_accessory_cusps present,_a_single_distal_accessory_cusp absent;
{101 Sectorial_postcanines,_distal_accessory_cusp_in_most_teeth:
large,_strongly_protruding_from_sectorial_crown reduced_in_size,_but_not_forming_a_crenulated_ridge
reduced_in_size,_and_forming_a_crenulated_ridge_with_the_mesial_accessory_cusps_of_similar_size;
{102 Sectorial_postcanines,_serrations_on_the_mesial_carina_in_some_teeth:
present_on_most_of_the_crown_height present_on_the_apical_part_of_the_crown absent;
{103 Sectorial_postcanines,_shape_of_mesial_denticles: convex
biserrated,_with_a_small_basal_denticle_and_a_larger_distal_denticle;
{104 Sectorial_postcanines,_cingulum/cingular_cusps_in_some_teeth: absent present_lingually present_labially
present_both_lingually_and_labially;
{105 Sectorial_postcanines,_labial_cingulum_in_some_upper_postcanines: well-
developed_multicuspid_cingulum_forming_a_collar non-cuspidate_ridge_not_forming_a_collar
one_or_two_cingular_cusps;
{106 Sectorial_postcanines,_labial_cingulum_in_some_lower_postcanines: well-
developed_multicuspid_cingulum_forming_a_collar
poorly_developed_multicuspid_cingulum_not_forming_a_collar one_or_two_cingular_cusps;
{107 Postcanine_occlusion: absent present;
{108 Deep_occlusal_basins_in_the_postcanines: absent present;
{109
Shearing_planes_between_the_outer_surface_of_the_main_cusp_of_the_lower_and_the_inner_surfaces_of_the_mai
n_cusps_of_the_upper_postcanines: present absent;
{110 Braided_and_oriented_enamel_surface_texture_in_some_incisors/canines:
absent,_enamel_texture_of_all_incisors/canines_smooth_or_irregular_and_non-oriented present;
{111 braided_and_oriented_enamel_surface_texture_in_some_postcanines:
absent,_enamel_texture_of_all_postcanines_smooth_or_irregular_and_non-oriented present;
{112 Lower_postcanines,_horizontal_labiolingual_constriction_between_crown_and_root_in_mesial/distal_view
absent_or_weak,_crown_and_root_(almost)_confluent important,_strong_constriction_between_crown_and_root;
{113 Postcanine_root,_length long,_more_than_twice_the_largest_crown_height
short,_less_than_twice_the_crown_height;
{114 Adult_maximum_skull_size: large_(greater_than_25_cm) medium_to_small;
{115 Snout_(preorbit)_in_adults_in_relation_to_temporal_region: longer subequal shorter;
{116 Two_side_of_temporal_fenestra_(outline_of_zygoma): divergent_posteriorly nearly_parallel
bulge_in_the_middle;
{117 Extranasal_process_of_the_premaxilla small large_but_not_contacting_the_nasal;
{118 Septomaxilla_facial_process long short;
{119 Carotid_artery_foramina_in_basisphenoid present absent;
{120 Mandibular_symphysis unfused fused;
{121 Zygomatic_arch_dorsoventral_height moderately_deep_ very_deep;
{122 Inferior_margin_of_jugal_in_the_zygoma low high;
{123 Premaxilla_forms_posterior_border_incisive_foramen: absent present;
{124 Vomer_exposure_in_incisive_foramen_(at_anterior_ends_of_maxillae_on_palate): present absent;
{125 Vomer_vertical_septum_extending_posteriorly_beyond_level_of_secondary_palate: present absent;
{126 Internarial_bar: present absent;
{127 Parietal_foramen_in_adults: present absent;

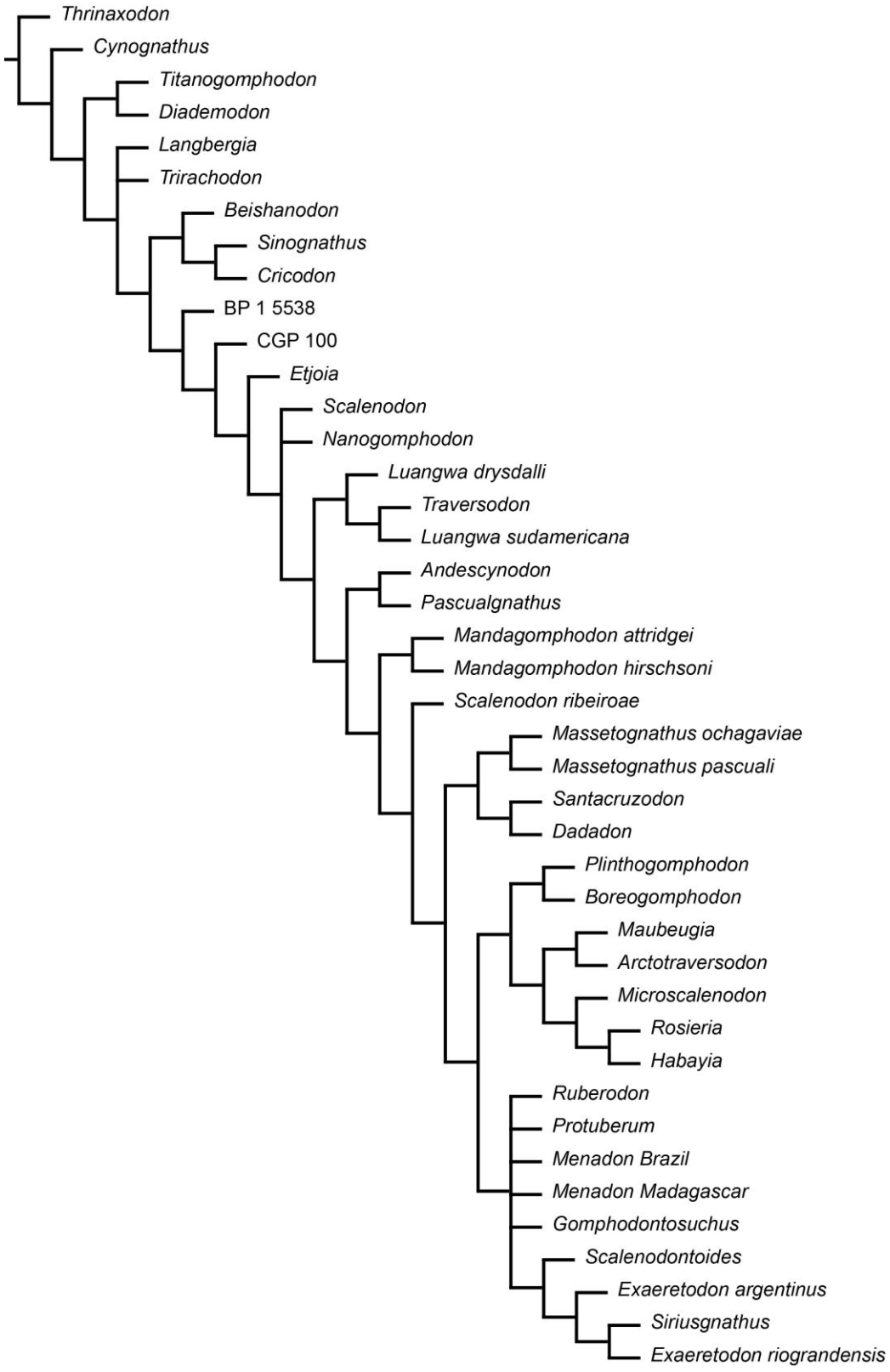
{128 Ectopterygoid: present absent;
{129 Posterior_extension_of_secondary_palate_relative_to_anterior_border_of_orbit: anterior subequal posterior;
{130 Posterior_extension_of_the_jugal_dorsally_above_the_squamosal_in_the_zygomatic_arch:
absent_or_with_small_extension well_developed;
{131 Position_of_anterior_root_of_the_zygomatic_arch_relative_to_the_ventral_margin_of_the_maxilla:
nearly_at_same_level_or_slightly_higher remarkably_higher;
{132 Zygomatic_process_of_the_jugal: little_projected conspicuously_projected absent a_ball-like_process;
{133 Diameter_of_suborbital_bar_below_center_of_orbit_(anterior_to_suborbital_process,_where_present):
greater_than_1/2_diameter_of_bar_below_posterior_part_of_orbit_(posterior_to_suborbital_process)
less_than_1/2_diameter_of_bar_below_posterior_part_of_orbit;
{134 Maxilla_in_the_margin_of_the_subtemporal_fenestra: excluded included;
{135 Epipterygoid-quadrate_contact: present absent;
{136 Frontal-epipterygoid_contact: present absent;
{137 Palatine: does_not_meet_frontal
meets_frontal_but_neither_element_contributes_significantly_to_medial_orbit_wall;
{138 Notch_separating_lambdoidal_crest_from_zygomatic_arch: shallow deep_v-shaped;
{139 Lower_jaw_symphysis_as_a_chin-like_process_in_adults: absent_or_little_developed well-developed;
{140 Dentary_with_sigmoid_ventral_curvature: absent present;
{141 Dentary_angular_process: not_or_very_weakly_projected_posteriorly
projected_posteriorly_as_distinct_process;
{142 Elongated_mental_foramen_below_postcanine_tooth_row_and_above_coronoid_ridge: absent present;
{143 Coronoid_ridge_anterior_to_masseteric_fossa: absent_to_low very_strong,_outturned;
{144 Maxillary_labial_platform_lateral_to_the_postcanine_series: absent present;
{145 Anapophysis: absent present;
{146 Expanded_costal_plates_on_ribs: present absent;
{147 Lumbar_costal_plates_with_ridge_overlapping_preceding_rib: present absent;
{148 Procoracoid_in_glenoid: present barely_present_or_absent;
{149 Dorsal_margin_of_the_coracoid_in_medial_view_related_to_that_of_the_procoracoid: shorter
equal_or_longer;
{150 Cranial_margin_of_the_procoracoid: convex nearly_straight obviously_concave;
{151 Angle_between_ventral_margin_on_anterior_and_posterior_process_of_iliac_blade:
small_(e.g.,_less_than_140_degree) large;
{152 Length_of_anterior_process_of_ilium_anterior_to_acetabulum_(relative_to_diameter_of_acetabulum):
less_than_1.5 greater_than_1.5;
{153 Dorsal_profile_of_ilium: convex flat_or_concave;
{154 The_trochanter_major_position_related_to_the_femoral_head: distal close,_major_part_in_same_height;
{155 Major_palatine_foramen: at_axillary/palatine_suture penetrating_palatine;
{156 Number_of_crurae: one two;
{157 Curvature_of_the_crurae: both_crurae_straight both_crurae_curved
posterior_crus_curved,_anterior_crus_straight;
{158 Relative_size_of_the_stapedial_foramen: large,_aprox_3/4_of_the_total_length_of_the_stapes medium-
sized,_aprox_2/3_of_the_total_length_of_the_stapes small,_aprox_1/2_of_the_total_length_of_the_stapes;
{159 Ossified_portion_of_the_stapes_medial_and_lateral_to_the_stapedial_foramen:
medial_and_lateral_ossified_sectors_restricted_to_the_fusion_of_the_crurae
medial_ossified_sector_constituting_a_platform lateral_ossified_sector_constituting_a_platform;
{160 Relative_size_of_the_ossified_portion_of_the_stapes_medial_and_lateral_to_the_stapedial_foramen:
medial_portion_wider_than_the_lateral_one lateral_platform_wider_than_the_medial_one
medial_portion_as_wide_as_the_lateral_one;
{161 Ossified_dorsal_process_of_the_stapes: present absent;
{162 Anterior_projection_of_the_medial_margin_of_the_stapes_in_ventral_view: absent present;
{163 Posterior_projection_of_the_medial_margin_of_the_stapes_in_ventral_view: absent present;
{164 Anterior_projection_of_the_lateral_margin_of_the_stapes_in_ventral_view: absent present;
{165 Posterior_projection_of_the_lateral_margin_of_the_stapes_in_ventral_view: absent present;
{166 Stapedial_footplate_expanded_dorsoventraly: absent present;
{167 Stapes_length_relative_to_the_skull_basal_length: greater_than_7% less_than_5.5%;
{168 Anteriorly_projected_process_that_contacts_the_anapophyses_in_the_cervical_vertebrae: absent present;

{169 Intercentra_in_the_cervical_postaxial_region: absent present;
{170 Inflated_anterior_and_posterior_margins_of_the_cervical_centra_in_lateral_view:
not_inflated_or_only_slightly_inflated very_inflated,_bulbous;
;

ccode + 1 7 11 18 19 26 28 30 33 35 36 41.44 51 71 73 74 91 115 129 150 *;

proc /;
comments 0
;

3.3 Result of the cladistic analysis conducted on our data matrix (unconstrained search; eight MPTs of 662 steps, CI 0.3565, RI 0.6019).



4. Phylogenetic analysis on Schmitt *et al.*'s (2019) dataset

4.1 Files

The Excel, Mesquite and TNT files are downloadable at https://drive.google.com/drive/folders/11dlHyrShbOo20cXeJcI1oUtjV6KIu_Xv?usp=sharing and can be obtained by request to the corresponding author.

4.2 Data matrix

xread
78 34
Thrinaxodon 10200000000020010000000000000?0000?000100010???00?-??-?????????????10100000000
Cynognathus 00000000000000001000000000010?0000?000000000???00?-??-?????????????00000000000
Diademodon 00000000000010001010000000000000[0 1]10000000001000000-
000?00000000???010000010000
Beishanodon 0210?00101002000??1?????000?1010???0?0??0????0000???00?000????????0??????????1
Cricodon 1??0??0???0???0???0????0000000?0101011100021000200000110000?00010100???0100??????0?
Langbergia 11101000010010000?0100000000000010111000100002000001000?00010100???0?????????0
Sinognathus 121??1?10100200???100000000010101110100000?30000010110??001010????0??????????
Trirachodon 1110100[0 1]0100100010100000000001010[0 1]11000000002000001[0
1]110?00010100???01000000000?0
'CGS_JSM_100' 1?1??00??1?0?0?????000000?01000001???1100012100001111100002010000000??????????
Andescynodon 11001101?100000???10000000001021010000100003101000-101?11021011101110??111111?
Arctotraversodon0??????????????????????10?11???0?????10?0021???3?010110?120?0?21121?001??????????
'Boreogomphodon_jeffersoni' 112??101?2002001??10011100001021110000100012220[0 1]1111[0
2]12010121[0 1]111[0 1]0101?112???11
Dadadon 11111101110010012?100?00110011210100002000131111111212010121020110 1???????????
'Exaeretodon_argentinus' 000111111111111?1101100211011220101011011310121?-00-
111121021111101?1?111110
'Exaeretodon_riograndensis' 000111111111111??10110021 1?1122010101110113101 21--00-
111121021111101?????1110
Gomphodontosuchus ????1?0??0?1??0????11?00110011200100 0?10111310111?-??-
011121021111?1???????????
'Luangwa_drysdalli' 101???00??00110??0101100000111210100000000030100111[0
2]12000121010100110100011 10?
'Luangwa_sudamericana'
1?????00?1?001?????11100000111210100000000030100111002000121010101?1??????????0
'Massetognathus_ochagaviae' 12111101120000 01?01??0001100112[1
2]010000?000131011111212 0?012102?1101??1???????0
'Massetognathus_pascuali'111111011100000100100000110 01[0 1]2[1
2]0100002011131011111121200012102001010 0?11111110
Menadon 10111?01?011210???10110011101010010001111103101110-01-111121021--1101?1?0111??
Pascualgnathus 110011?1?100000??0100000000010210101001000013000000-100?110210?????110100?0011?
Protuberum 101?11101111111??1?????211?1122?101?1111?131?1110-0121111????????110?????????
Santacruzodon 1?????0??0?03??????011000000112101000020??13101111121200012102010 11??????????0
'Scalenodon_angustifrons' 110???00???0200???10??000000102001000000000301001 1111[0
2]0000210100001??????00?0?
'Mandagomphodon_attridgei'
???0110??1????0?????????000?1121?101?0100?131000111012101 1????????1??????????0
'Mandagomphodon_hirschoni'
1??0110?11?0?001?1?00?000000112101011011101310001110121001210100001????????????
Scalenodontoides012???11?111?11???11?10021101?22010101 11?11310121?-00-?111210211111????????????
Traversodon 1???1?00?1?1110????11100000011210100001000131100111?020001210 2?0?01?0111????1?
Nanogomphodon ??????????????????????????????????????10????????????????????????211001101????????????

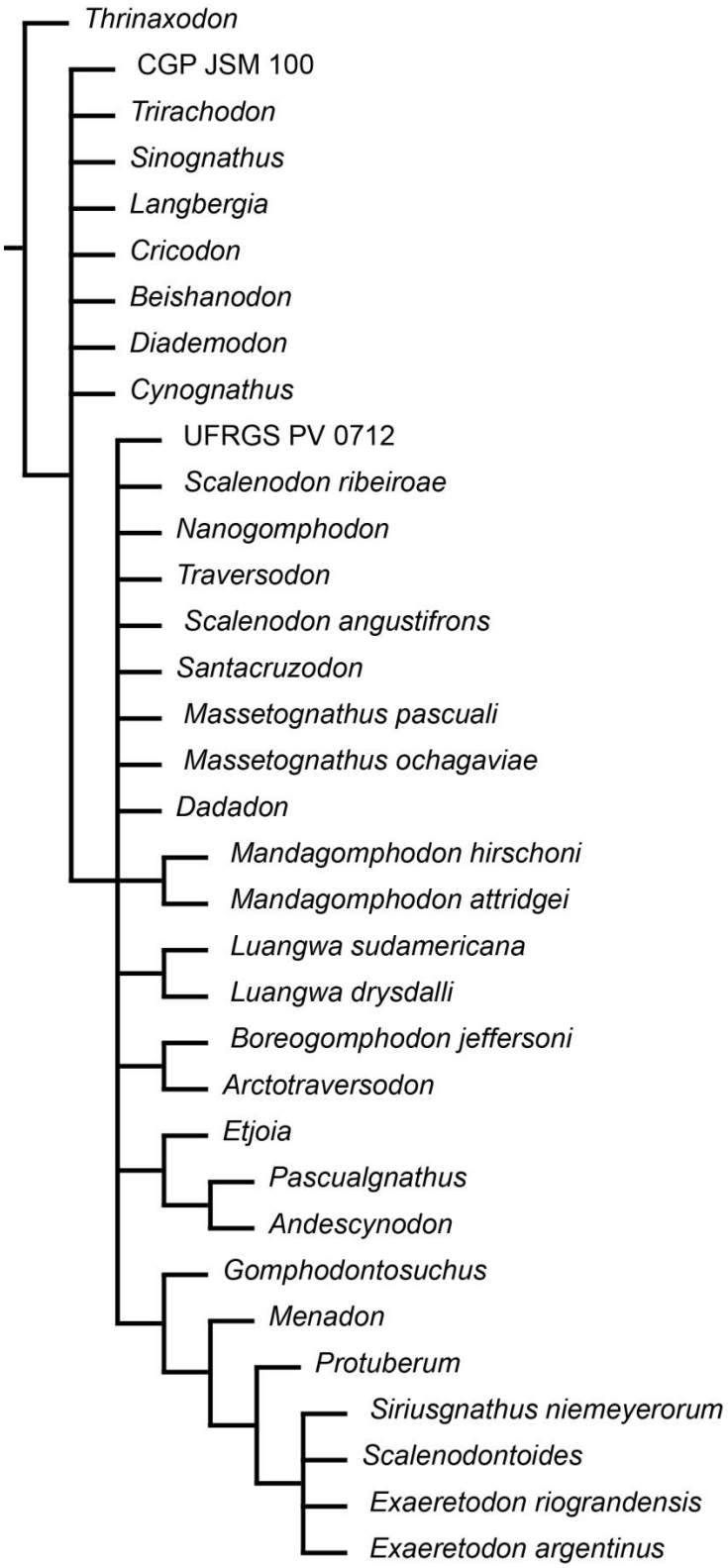
'Scalenodon_ribeiroae' 1??1??0??1?02?0?????????110?1021?100?0?01??3010011111[0
2]0000????????1???????????
'Siriusgnathus_niemeyerorum'
0?0?1111121101????10110021111122010?111101131012 1??00?111121021111 1???????????
'UFRGS_PV_0712'
121?????110?20?1?0100?01??00112101 0?00?0???3101111121200012102??101???????????
Etjoia 121???10?101000???10000000010011110001200001001001110001102100130011??????????
;

cnames
{0 Adult_maximum_skull_size: large_(greater_than_25_cm) medium_to_small;
{1 Snout_(preorbit)_in_adults_in_relation_to_temporal_region: longer subequal shorter;
{2 Two_side_of_temporal_fenestra: divergent_posteriorly nearly_parallel bulge_in_the_middle;
{3 Premaxilla_forms_posterior_border_incisive_foramen: absent present;
{4 Vomer_exposure_in_incisive_foramen_(at_anterior_ends_of_maxillae_on_palate): present absent;
{5 Vomer__vertical_septum_extending_posteriorly_beyond_level_of_secondary_palate: present absent;
{6 Internarial_bar: present absent;
{7 Parietal_foramen_in_adults: present absent;
{8 Ectopterygoid: present absent;
{9 Posterior_extension_of_secondary_palate_relative_to_anterior_border_of_orbit: shorter subequal longer;
{10 Posterior_extension_of_the_jugal_dorsally_above_the_squamosal_in_the_zygomatic_arch:
absent_or_with_small_extension well_developed;
{11 Position_of_anterior_root_of_the_zygomatic_arch_relative_to_the_ventral_margin_of_the_maxilla:
nearly_at_same_level_or_slightly_higher remarkably_higher;
{12 Zygomatic_process_of_the_jugal: little_projected conspicuously_projected absent a_ball-like_process;
{13 Diameter_of_suborbital_bar_below_center_of_orbit_(anterior_to_suborbital_process,_where_present):
greater_than_1/2_diameter_of_bar_below_posterior_part_of_orbit_(posterior_to_suborbital_process)
less_than_1/2_diameter_of_bar_below_posterior_part_of_orbit;
{14 Maxilla_in_the_margin_of_the_subtemporal_fenestra: excluded included;
{15 Epipterygoid-quadrate_contact: present absent;
{16 Frontal-epipterygoid_contact: present absent;
{17 Palatine: does_not_meet_frontal
meets_frontal_but_neither_element_contributes_significantly_to_medial_orbit_wall;
{18 Notch_separating_lambdoidal_crest_from_zygomatic_arch: shallow deep_v-shaped;
{19 Lower_jaw_symphysis_as_a_chin-like_process_in_adults: absent_or_little_developed well-developed;
{20 Dentary_with_sigmoid_ventral_curvature: absent present;
{21 Dentary_angular_process: not_or_very_weakly_projected_posteriorly
projected_posteriorly_as_distinct_process;
{22 Elongated_mental_foramen_below_postcanine_tooth_row_and_above_coronoid_ridge: absent present;
{23 Coronoid_ridge_anterior_to_masseteric_fossa: absent_to_low very_strong,_outturned;
{24 Position_of_the_upper_canine_in_relation_to_paracanine_fossa: postero-lateral lateral antero-lateral;
{25 Diastema_between_upper_incisors_and_canine: present absent;
{26 Diastema_between_canine_and_maxillary_postcanines_in_adult: short long;
{27 Diastema_between_canine_and_dentary_postcanines: long absent_or_very_short;
{28 Maxillary_labial_platform_lateral_to_the_postcanine_series: absent present;
{29 Posteromedial_inclination_of_the_last_few_upper_gomphodont_postcanines: absent_or_small oblique;
{30 Axis_of_posterior_part_of_maxillary_tooth_row: directed_lateral_to_the_temporal_fossa
directed_towards_center_of_fossa directed_towards_medial_rim_of_fossa;
{31 Maxillary_tooth_row_extent_relative_to_anterior_margin_of_the_subtemporal_fossa_in_adult: anterior
at_the_same_level posterior;
{32 Coronoid_process_of_the_mandible: cover_the_last_postcanine does_not_cover;
{33 Postcanine_occlusion: absent present;
{34
Shearing_planes_between_the_outer_surface_of_the_main_cusp_of_the_lower_and_the_inner_surfaces_of_the_mai
n_cusps_of_the_uppers_postcanines: present absent;
{35 Upper_incisor_number: four three;

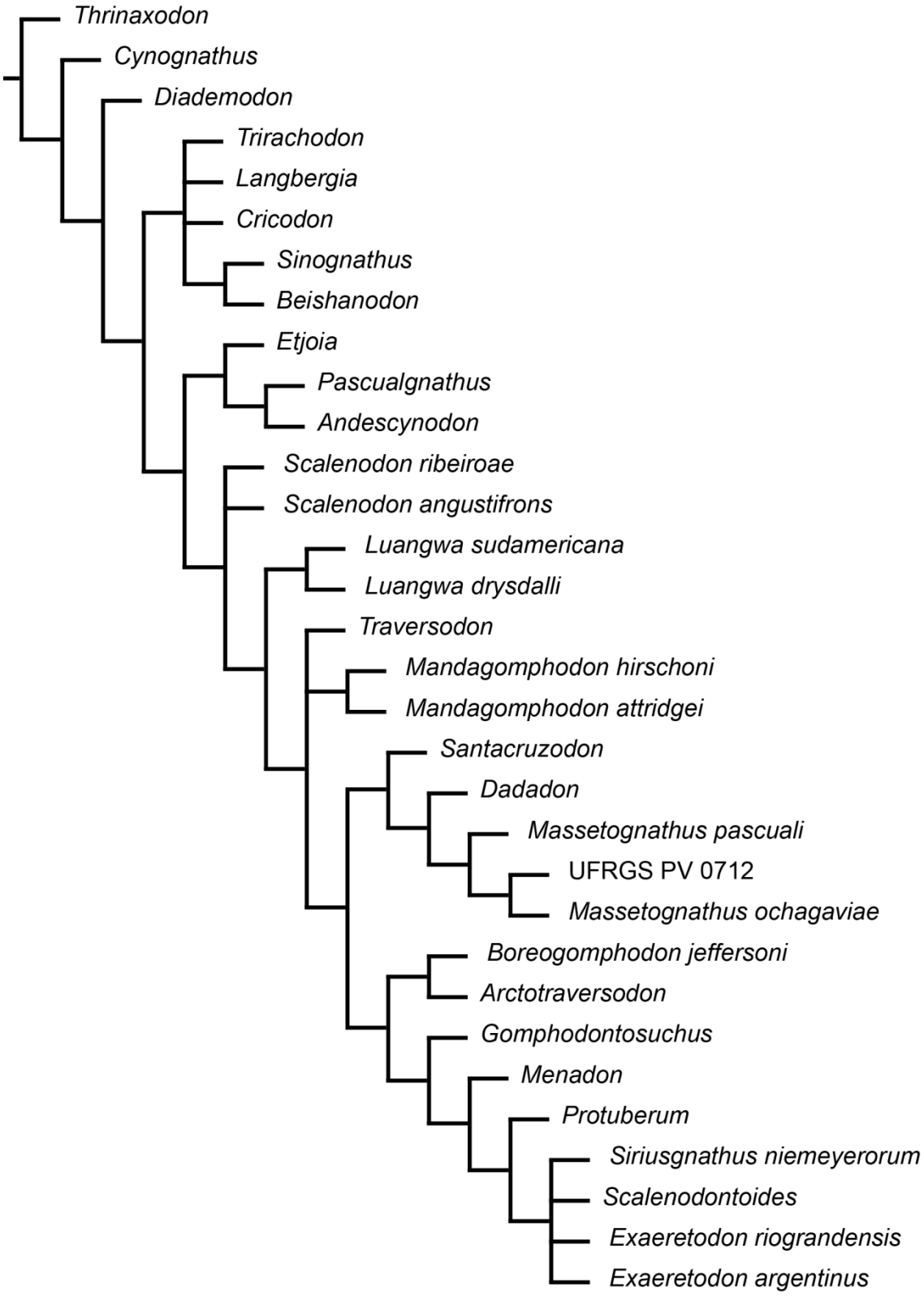
{36 Lower_incisor_number: three two;
{37 Incisor_procumbency: absent present;
{38 Incisor_cutting_margins: serrated smoothly_ridged denticulated;
{39 Incisor_size: small enlarged;
{40 Upper_canine_size: large reduced_in_size;
{41 Lower_canine_size: large reduced_in_size;
{42 Canine_serrations: present absent;
{43 Postcanine_tooth_row_in_adults: sectorial conical,_gomphodont_and_sectorial gomphodont_and_sectorial gomphodont;
{44 Overall_morphology_of_the_upper_gomphodont_postcanines_in_occlusive_view: ovoid-ellipsoid nearly_rectangular nearly_triangular;
{45 Labial_cingulum_on_anterior_portion_of_the_upper_postcanines_(external_to_the_sectorial_ridge): absent present;
{46 Posterior_cingulum_on_upper_postcanines: present absent;
{47 Shouldering_in_the_posterior_margin_of_upper_postcanines: absent slightly_developed well-developed;
{48 Anterior_profile_of_principal_labial_cusp: convex concave;
{49 Number_of_cusps_in_the_transverse_crest_of_the_upper_postcanines: two three_or_more;
{50 Central_cusp_of_upper_transverse_row: midway_between_labial_and_lingual_cusps closer_to_lingual_cusp;
{51 Anterolabial_accessory_cusp_on_upper_postcanines: absent one two_or_more;
{52 Posterolabial_accessory_cusp_on_upper_postcanines: present absent;
{53 Position_of_upper_transverse_cusp_row_on_crown: anterior_half_of_the_crown central posterior_half_of_the_crown;
{54 Distinct_anterolingual_accessory_cusp_on_upper_postcanines: absent present;
{55 Anterior_cingulum_in_the_upper_postcanines: present absent;
{56 Anterior_transverse_crest_on_upper_postcanines: absent_or_low high;
{57 Lingual_ridge_on_upper_postcanines: absent present;
{58 Overall_morphology_of_the_lower_gomphodont_postcanines_in_occlusal_view: circular ovoid-ellipsoid quadrangular;
{59 Transverse_crest_in_lower_postcanines: central anterior;
{60 Number_of_cusps_in_the_transverse_crest_of_the_lower_postcanines: two three_or_more;
{61 Anterior_cingulum_in_the_lower_postcanines:_cuspules: cuspules_disposed_on_the_entire_margin one_or_more_cuspules_located_anterolabially absent;
{62 Posterior_cingulum_on_the_lower_gomphodont_postcanines: present absent;
{63 Size_of_the_anterior_cusps_in_the_lower_postcanines: labial_lower_than_lingual labial_higher_than_lingual;
{64 Widest_lower_cusp_in_transverse_row_of_lower_postcanines: lingual labial middle;
{65 Anterolingual_cusp_of_lower_postcanines: nearly_vertical strongly_inclined_posteriorly;
{66 Deep_occlusal_basins_in_the_postcanines: absent present;
{67 Anapophysis: absent present;
{68 Expanded_costal_plates_on_ribs: present absent;
{69 Lumbar_costal_plates_with_ridge_overlapping_preceding_rib: present absent;
{70 Procoracoid_in_glenoid: present barely_present_or_absent;
{71 Dorsal_margin_of_the_coracoid_in_medial_view_in_related_to_that_of_the_procoracoid: shorter equal_or_longer;
{72 Cranial_margin_of_the_procoracoid: convex nearly_straight obviously_concave;
{73 Angle_between_ventral_margin_on_anterior_and_posterior_process_of_iliac_blade: small_(e.g.,_less_than_140_degree) large;
{74 Length_of_anterior_process_of_ilium_anterior_to_acetabulum_(relative_to_diameter_of_acetabulum): less_than_1.5 greater_than_1.5;
{75 Dorsal_profile_of_ilium: convex flat_or_concave;
{76 The_trochanter_major_position_related_to_the_femoral_head: distal close,_major_part_in_same_height;
{77 Major_palatine_foramen: at_maxillary/palatine_suture penetrating_palatine;
;

proc /;
comments 0
;

4.3 Result of the cladistic analysis conducted on Schmitt *et al.*'s (2019) data matrix (unconstrained search; 100 MPTs of 333 steps, CI 0.2913, RI 0.528).



4.4 Result of the cladistic analysis conducted on Schmitt *et al.*'s (2019) data matrix after the a posteriori deletion of CGS JSM 100 and *Nanogomphodon* (unconstrained search; 6 MPTs of 233 steps, CI 0.4163, RI 0.728).



5. Phylogenetic analysis on Sidor and Hopson's (2018) dataset

5.1 Files

The Excel, Mesquite and TNT files are downloadable at https://drive.google.com/drive/folders/1WiBy75P4YCsu2DD9G0Rq2HnwDiRJvgSf?usp=sharing and can be obtained by request to the corresponding author.

5.2 Data matrix

xread
75 27
Procynosuchus 0000000000000000000000000000000000000000000?00??????000?000000000000000000
Galesaurus 0000000000010001010010000001111011100000010?00??????0?0?0000100000000101?00
Thrinaxodon 0000011100010001010010000001111011100000000?00??????000?0000100000000101000
Cynognathus 0000011100021012021011100011122121110001010?00??????000?000?111000011000100
Diademodon 0000011100021112021021100111122121 1?0000022110000000100?001111100011011 1000
Trirachodon ?0000111010211 1?021121100111122121110001022110000010200?2221111000110101000
Cricodon ?00001110??????2?2????1??0111122121110001022110000010200?2221111000110 10?000
Langbergia 0000011101021112?2??211001111211?1100001022110000010200?0111111???11010?000
Pascualgnathus ?0000111010211120211211001111221221000000210010100101?1012321111?0??0111000
Scalenodon 0000011100121112021121100111122121110001122122000010101012321???????0??1???
Mandagomphodon 0000?11101??11?2?2????1?00111122??2201100022122101010101022 32?????????????????
Luangwa ?10001110??21112021121 1?0111122121 11000?122122101010101022321011 00??1111000
Massetognathus 1100011102121102021121100111122121120110122222100010111022321011101111111 0?0
Gomphodontosuchus ?100?11100??1??2021??1?00?1112212110011002120210111111112232?????????????????
Exaeretodon ?100111101?21012?2112110011112212210101002120211111111112232001110111011000
Tritylodontidae 1?1111102121102111121100101122122201 22?0222121?101010??2232001111111211111
Lumkuia 0000111101010001020011000111122121100000010?00??????000?0001001?10????????0
Probainognathus 1000111111010001120011000111122121100000000?00??????000?0101001 1????111?000
Ectininion ?0001111010?0001120011000111122121100001 0?0?00??????0?0?000??0?????????????
Probelesodon 1000111112010001120011011111122121100000?010?00??????000?000?00111011111?000
Aleodon 10001111220?0001120??102??111221212 0000?021?00??????100?1111?0???0?????????
Chiniquodon ?0001111220100011200110211111221211 0000?021?00??????100?000??01110??1111000
Pachygenelus 1011111122000000100011020???122122201110100?00??????000?0200001111??1211111
Morganucodon 0011111122000000100121000101122121000010100?00??????000?0101001111111211111
Sinognathus ?0001111010 21?02?????10?01111221?12?000002211000?01010??113?????????????????
Beishanodon 000011110101?001?????10001????????1??000?0222??00?010????123?????????????????
Etjoia ?0000?1101?21112??????00011112???1120001022110000 01?1010011?????????????????
;

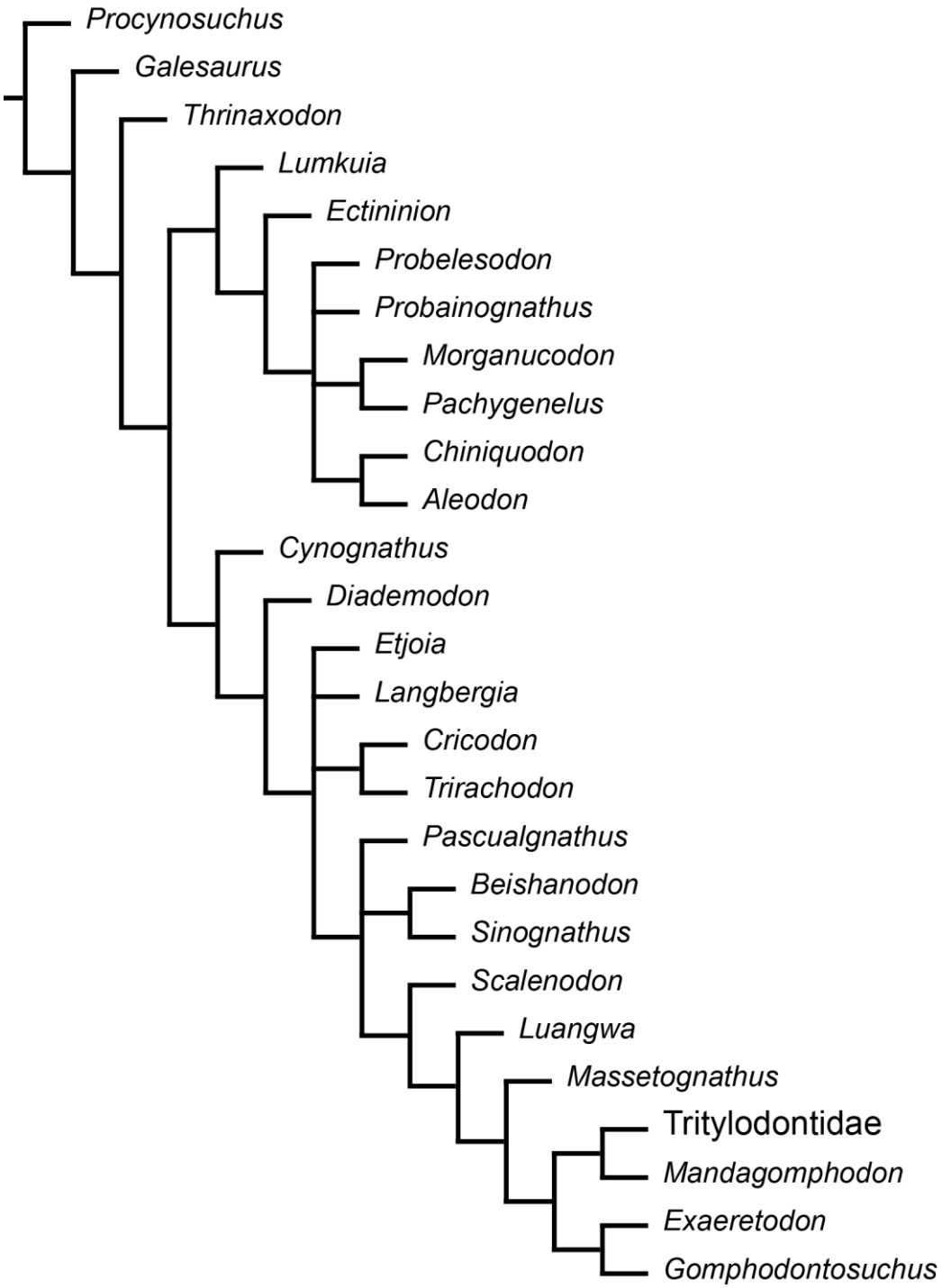
cnames
{0 (1)_Premaxilla_forms_posterior_border_incisive_foramen absent_ present;
{1 (2)_Position_of_paracanine_fossa_relative_to_upper_canine anterolingual_ lingual_to_posterolingual;
{2 (3)_Prefrontal present_ absent;
{3 (4)_Postorbital present_ absent;
{4 (5)_Parietal_foramen present_ absent;
{5 (6)_Vomer_internarial_shape broad_plate_ parallel-sided_keel;
{6 (7)_Secondary_palatal_plate_on_maxilla does_not_reach_midline_ reaches_midline;
{7 (8)_Secondary_palatal_plate_on_palatine extends_nearly_to_midline_ reaches_midline;
{8 (9)_Length_secondary_palate_relative_to_tooth_row shorter_ about_equal_ _longer;
{9 (10)_Length_secondary_palate_relative_anterior_border_of_orbit shorter_ about_equal_ _longer;
{10 (11)_Ventral_surface_of_basisphenoid_depressed_below_occipital_condyles less_than_1/4_occipital_height_ greater_than_1/4_occipital_height;
{11 (12)_Zygomatic_arch_dorsoventral_height slender_ moderately_deep_ _very_deep;

{12 (13)_Zygomatic_arch_dorsal_extent_immediately_behind_orbit below_middle_of_orbit_
above_middle_of_orbit;
{13 (14)_Jugal_depth_in_zygomatic_arch_relative_to_exposed_squamosal_depth less_than_twice_
greater_than_twice;
{14 (15)_Jugal_suborbital_process absent_ present;
{15 (16)_Squamosal_groove_for_external_auditory_meatus shallow_ moderately_deep_ _very_deep;
{16 (17)_Frontal-palatine_contact_in_orbit absent_ present;
{17 (18)_Descending_flange_of_squamosal_lateral_to_quadratojugal absent_ present,_not_contacting_surangular_
_present,_contacting_surangular;
{18 (19)_Internal_carotid_foramina_in_basisphenoid present_ absent;
{19 (20)_Groove_on_prootic_extending_from_pterygoparoccipital_foramen_to_trigeminal_foramen
present_and_open_ present_and_enclosed_as_a_canal;
{20 (21)_Trigeminal_nerve_exit between_prootic_incisure_and_epipterygoid_
via_foramen_between_prootic_and_epipterygoid_ _via_two_foramina;
{21 (22)_Quadrate_ramus_of_pterygoid present_ absent;
{22 (23)_Greatest_width_of_zygomatic_arch about_middle_of_arch_(anterior_to_level_of_quadrate)_
at_posterior_end_of_arch_(at_level_of_quadrate);
{23 (24)_Length_of_palatine_relative_to_maxilla_in_secondary_palate shorter_ about_equal_ _longer;
{24 (25)_Posterolateral_end_of_maxilla passes_obliquely_posterodorsally_into_suborbital_bar_
forms_right_angle_ventral_to_jugal_contact;
{25 (26)_'V'-shaped_notch_separating_lambdoidal_crest_from_zygomatic_arch absent_ present;
{26 (27)_Dentary_symphysis not_fused_ fused;
{27 (28)_Dentary_masseteric_fossa high_on_coronoid_region_ extends_to_lower_border_of_dentary;
{28 (29)_Dentary_coronoid_process_height below_middle_of_orbit_ above_middle_of_orbit;
{29 (30)_Position_of_dentary-surangular_dorsal_contact_relative_to_postorbital_bar_and_jaw_joint
closer_to_postorbital_bar_ midway_between_ _closer_to_jaw_joint;
{30
(31)_Postdentary_rod_height_relative_to_exposed_length_(distance_between_base_of_reflected_lamina_and_jaw_j
oint) greater_than_one-half_length_ about_one-half_length_ _less_than_one-half_length;
{31 (32)_Reflected_lamina_of_angular_posterior_extent_relative_to_distance_from_angle_of_dentary_to_jaw_joint
greater_than_one-half_the_distance_ less_than_one-half_the_distance;
{32 (33)_Reflected_lamina_of_angular_shape spoon-shaped_plate_ hook_with_depth_greater_than_one-
half_length_ _hook_with_depth_less_than_one-half_length;
{33 (34)_Upper_incisor_number five_or_more_ four_ _three;
{34 (35)_Lower_incisor_number four_or_more_ three_ _two;
{35 (36)_Incisor_cutting_margins smoothly_ridged_ serrated_ _denticulated;
{36 (37)_Incisor_size all_small_ some_or_all_enlarged;
{37 (38)_Upper_canine_size large_ reduced_in_size_ _absent;
{38 (39)_Lower_canine_size large_ reduced_in_size_ _absent;
{39 (40)_Canine_serrations absent_ present;
{40 (41)_Upper_postcanine_buccal_cingulum absent_ present;
{41 (42)_Postcanine_lingual_cingulum narrow_ absent_ _lingually_expanded;
{42 (43)_Number_of_upper_cusps_in_transverse_row one_ two_ _three_or_more;
{43 (44)_Position_of_upper_transverse_cusp_row_on_crown on_anterior_half_of_crown_
from_midcrown_almost_to_posterior_margin_ _at_posterior_margin_(no_posterior_cingulum);
{44 (45)_Central_cusp_of_upper_transverse_row absent_ about_midway_between_buccal_and_lingual_cusps_
_closer_to_lingual_cusp;
{45 (46)_Longitudinal_shear_surface_of_main_upper_buccal_cusp
anterior_and_posterior_(to_transverse_ridge,_if_present)_ posterior_only_ _anterior_only;
{46 (47)_Upper_anterobuccal_accessory_cusp present_ absent;
{47 (48)_Upper_posterobuccal_accessory_cusp present_ absent;
{48 (49)_Upper_anterolingual_accessory_cusp absent_ present;
{49 (50)_Upper_anterior_transverse_(cingulum)_ridge low_ high;
{50 (51)_Upper_lingual_ridge absent_ present;
{51 (52)_Transverse_axis_of_crown_strongly_oblique_to_midline_axis absent_ present;
{52 (53)_Number_of_lower_cusps_in_transverse_row one_ two_ _three_or_more;

{53 (54)_Lower_anterior_cingulum_or_cusp present_ absent;
{54 (55)_Posterior_occlusal_basin_on_lower_postcanines absent_ present;
{55 (56)_Wider_lower_cusp_in_transverse_row lingual_(0)_buccal;
{56 (57)_Posterior_portion_maxillary_tooth_row_inset_from_lateral_margin_of_maxilla_(cheek_developed)
absent_ moderately_set_in_ _well_set_in;
{57 (58)_Axis_of_posterior_part_of_maxillary_tooth_row directed_lateral_to_subtemporal_fossa_
directed_towards_center_of_fossa_ _directed_toward_medial_rim_of_fossa;
{58 (59)_Number_of_posterior_sectorial_postcanines six_or_more_ three_or_four_ _one_or_two_
none_(gomphodont);
{59 (60)_Postcanine_replacement_pattern_in_adult 'alternating'_
widely_spaced_waves_(three_or_more_teeth_per_wave)_ _single_wave;
{60 (61)_Expanded_costal_plates_on_ribs absent_ present;
{61 (62)_Lumbar_costal_plates_with_ridge_overlapping_preceding_rib absent_ present;
{62 (63)_Acromion_process absent_ present;
{63 (64)_Scapular_constriction_below_acromion absent_ present;
{64 (65)_Procoracoid_in_glenoid present_ barely_present_or_absent;
{65 (66)_Procoracoid_contact_with_scapula greater_than_coracoid_contact_
equal_to_or_less_than_coracoid_contact;
{66 (67)_Manual_digit_III_phalanx_number four_ three;
{67 (68)_Manual_digit_IV_phalanx_number four_ three;
{68 (69)_Length_of_anterior_process_of_ilium_anterior_to_acetabulum_(relative_to_diameter_of_acetabulum)
between_1.0_and_1.5_ greater_than_1.5;
{69 (70)_Length_of_posterior_process_of_ilium_posterior_to_acetabulum_(relative_to_diameter_of_acetabulum)
between_0.5_and_1.0_ greater_than_1.0_ _less_than_0.5;
{70 (71)_Dorsal_profile_of_ilium strongly_convex_ flat_to_concave;
{71 (72)_Total_length_of_pubis_relative_to_acetabulum_diameter Between_1.5_and_1.0_ less_than_1.0;
{72 (73)_Greater_trochanter_separated_from_femoral_head_by_distinct_notch absent_ present;
{73 (74)_Lesser_trochanter_position on_ventromedial_surface_of_femoral_shaft_
on_medial_surface_of_femoral_shaft;
{74 (75)_Vertebral_centra amphicoelous_ platycoelous;
;

proc /;
comments 0
;

5.3 Result of the cladistic analysis conducted on Sidor and Hopson's (2018) data matrix (unconstrained search; six MPTs of 208 steps, CI 0.4904, RI 0.709).



6. Skull length, body length, and body mass in basal cynodonts

Taxon	Specimen	Skull length	Body length	Skull/body length	Source	Remarks
Thrinaxodon	Composite	NA	NA	0.17	Jenkins (1971): first figure	
Thrinaxodon	BP/1/7199	75	NA	0.176-0.178	Fernandez *et al.* (2013): figure 2A-B; Jasinoski & Abdala (2017)	
Diademodon	SAM K5278	113	535	0.2112	Gow & Grine (1979)	*Diademodon*'s tail is too short in Brink (1955): figure 7
Massetognathus	Composite	NA	NA	0.1916	Jenkins (1970): figure 9	

Table A1. Data on skull length, body length and skull/body length ratio in basal cynodonts and gomphodonts. Skull and body length in mm.

Mancuso *et al.*'s (2014) formula for cynodont body mass (skull length in mm) is the following:

log (body mass) = 3.13*log(skull length) - 5.59

Taxon	Specimen	Skull length	Body mass	Source (skull length)
Etjoia dentitransitus	GSN F1591	88.5	3.19	Pers. measurements
Diademodon tetragonus	BP/1/2522	293	135.3	(Brink 1963)
Titanogomphodon crassus	GSN R322	430	449.53	(Keyser 1973)
Langbergia modisei	NMQR 3255; BP/1/5362	113	6.86	(Abdala *et al.* 2006)
Trirachodon berryi	BP/1/4658	102.7	5.08	Pers. measurements
Cricodon metabolus	BP/1/5540	160	20.36	(Abdala *et al.* 2005)
Cricodon metabolus	NA	180	29.44	(Sidor & Hopson 2018)
Sinognathus gracilis	IVPP V2339	113	6.86	ImageJ based on photo of cranium
Beishanodon youngi	PKUP V3007	270	104.7	(Gao *et al.* 2010)
Traversodontidae indet.	CGS JSM 100	41.66	0.302	Pers. measurements
Pascualgnathus polanskii	PVL 4416	124.22	9.22	Pers. measurements; 100-120 mm according to Martinelli (2010)
Andescynodon mendozensis	PVL 3900	137	12.53	(Liu & Powell 2009)
Scalenodon angustifrons	UMCZ T907 (Specimen 119B)	190	34.88	Estimation based on upper postcanine width vs. skull length of UMCZ T907 (Specimen 120B; holotype)
Luangwa drysdalli	BP/1/3731	142	14.017	Pers. measurements; 136 mm according to Abdala and Sa-Teixeira (2004)
Luangwa sudamericana	UFRGS-PV 267	94	3.85	(Abdala & Sa-Teixeira 2004)
Luangwa sp.	CGS R 572	204	43.56	(Abdala & Smith 2009)
Traversodon stahleckeri	UFRGS-PV 0224T	240	72.45	(Barberena 1981)

Table A2. Data on maximum skull length (in mm) and body mass (in kg) in basal gomphodonts. Estimations of body mass based on Mancuso *et al.*'s (2014) formula for cynodont (see above).

7. Coronal section through the skull of *Etjoia dentitransitus* (GSN F1591) at the level of the main crack

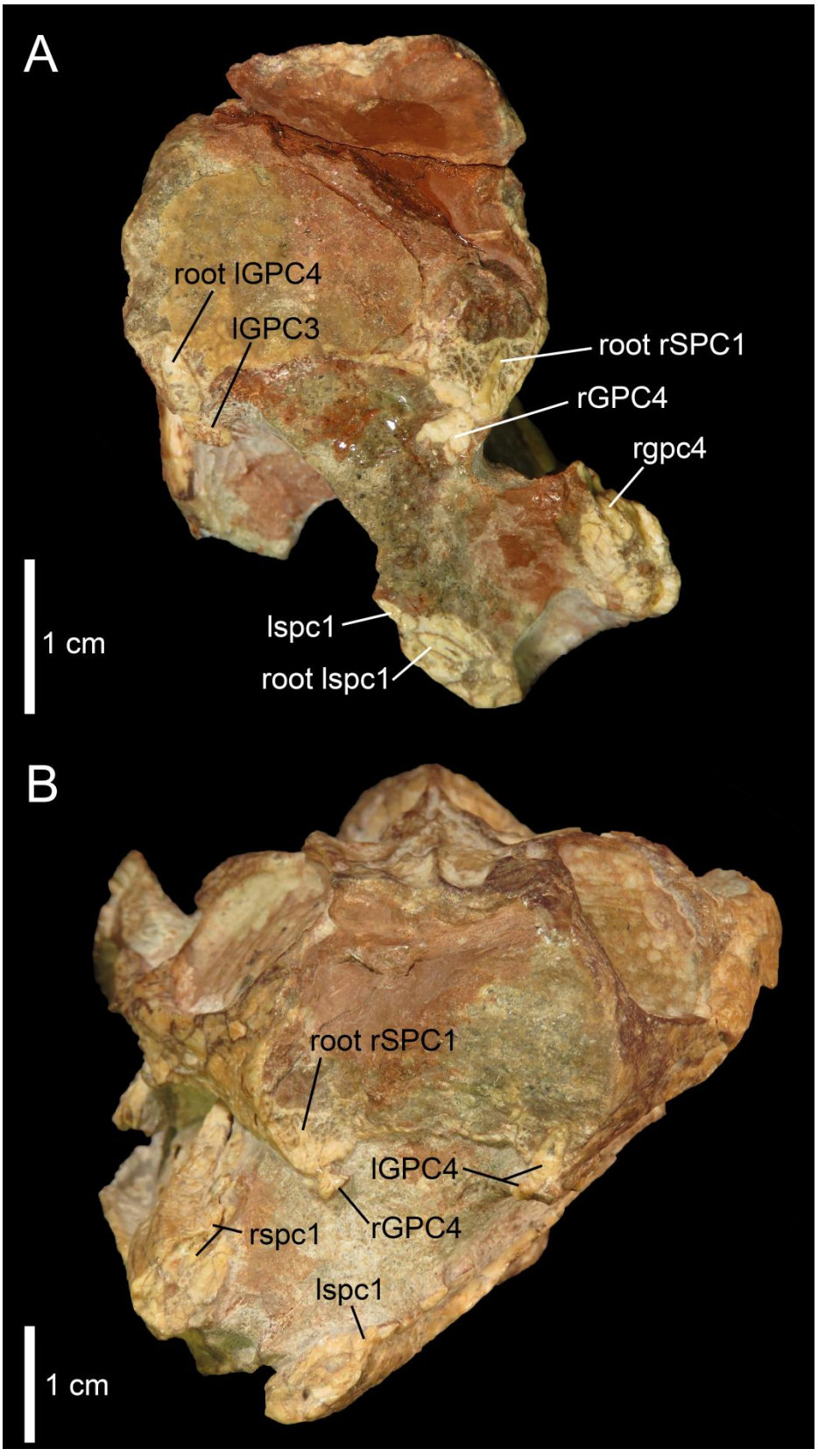


Figure A3. Coronal section of the skull of *Etjoia dentitransitus* (GSN F1591) at the level of the last upper gomphodont and first lower sectorial postcanines. **A,** anterior and; **B,** posterior portions of cranium and mandible in **A,** posterior, and **B,** anterior views. Abbreviations: lGPC, left upper gomphodont postcanine; lspc, left lower sectorial postcanine; rgpc, right lower gomphodont postcanine; rGPC, right upper gomphodont postcanine; rspc, right lower sectorial postcanine; rSPC, right upper sectorial postcanine.

8. CT-scan imagery of *Etjoia dentitransitus* (GSN F1591)

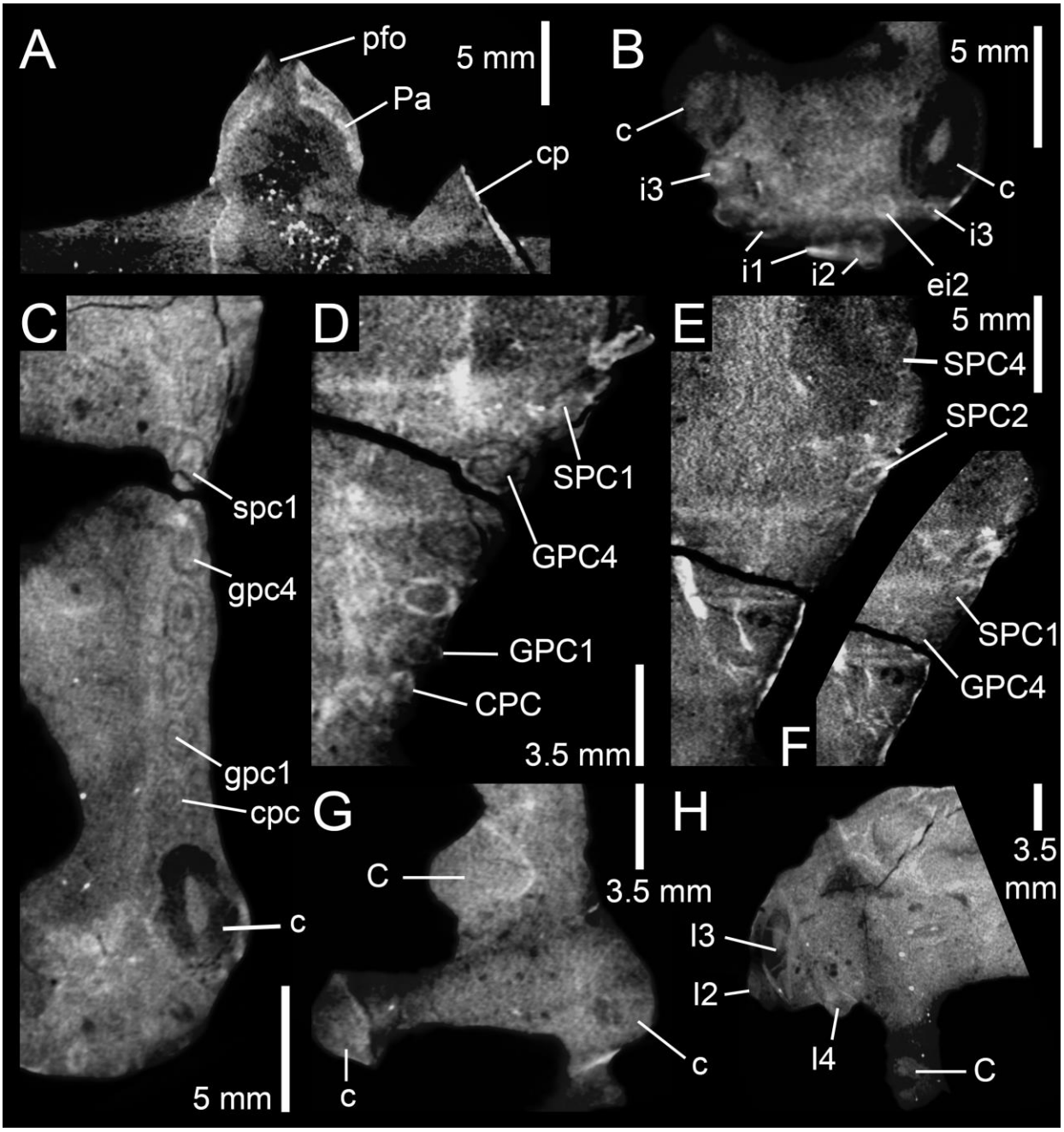


Figure A1. Internal morphology and μCT virtual sections of the skull of *Etjoia dentitransitus* (GSN F1591) derived from CT-scan data. **A,** Coronal section through the parietal foramen; **B,** transverse section though the lower incisors and canines; **C,** transverse section though the right mandibular dentition; **D-F,** transverse section through the right upper postcanine dentition at the level of **D,** the crowns of the gomphodont postcanines; **E,** the crowns of the last two sectorial postcanines, and **F,** the crowns of the first two sectorial postcanines; **G,** transverse section through the upper right and lower canines; **H,** sagittal section through the upper incisors and

canine. Abbreviations: c, lower canine; C, upper canine; cp, coronoid process; cpc, lower conical postcanine; CPC, upper conical postcanine; gpc, lower gomphodont postcanine; GPC, upper gomphodont postcanine; i, lower incisor; I, upper incisor; Pa, parietal; pfo, parietal foramen.

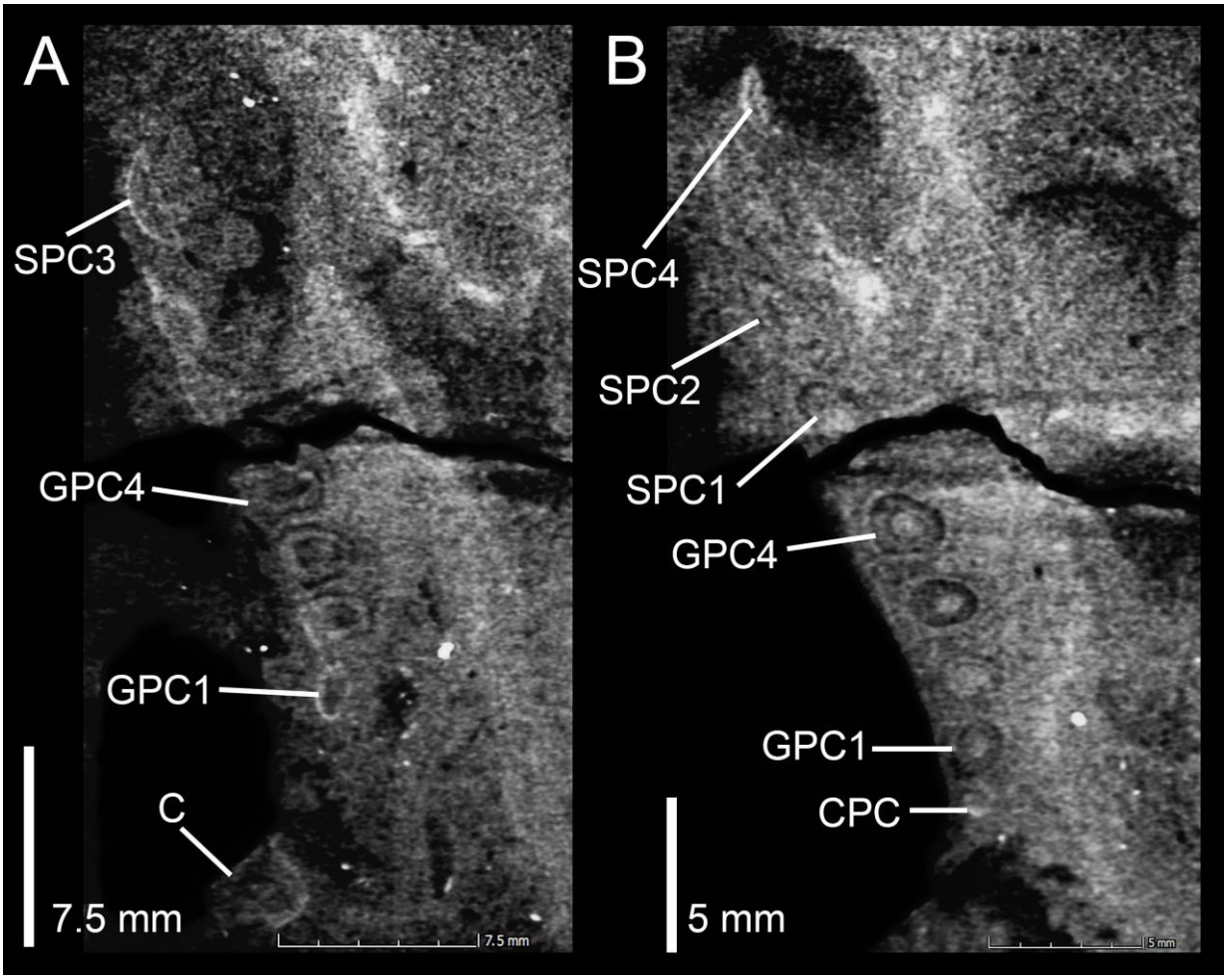


Figure A2. Internal morphology and μCT virtual sections of the upper jaw of *Etjoia dentitransitus* (GSN F1591) derived from CT-scan data. Transverse section through the left canine and postcanine tooth row at the level of **A,** the crowns; and **B,** the roots of the gomphodont teeth. Abbreviations: C, upper canine; CPC, upper conical postcanine; GPC, upper gomphodont postcanine; SPC, upper sectorial postcanine.

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