Supplementary Material for

Endocranial anatomy and life habits of the Early Triassic archosauriform *Proterosuchus fergusi*

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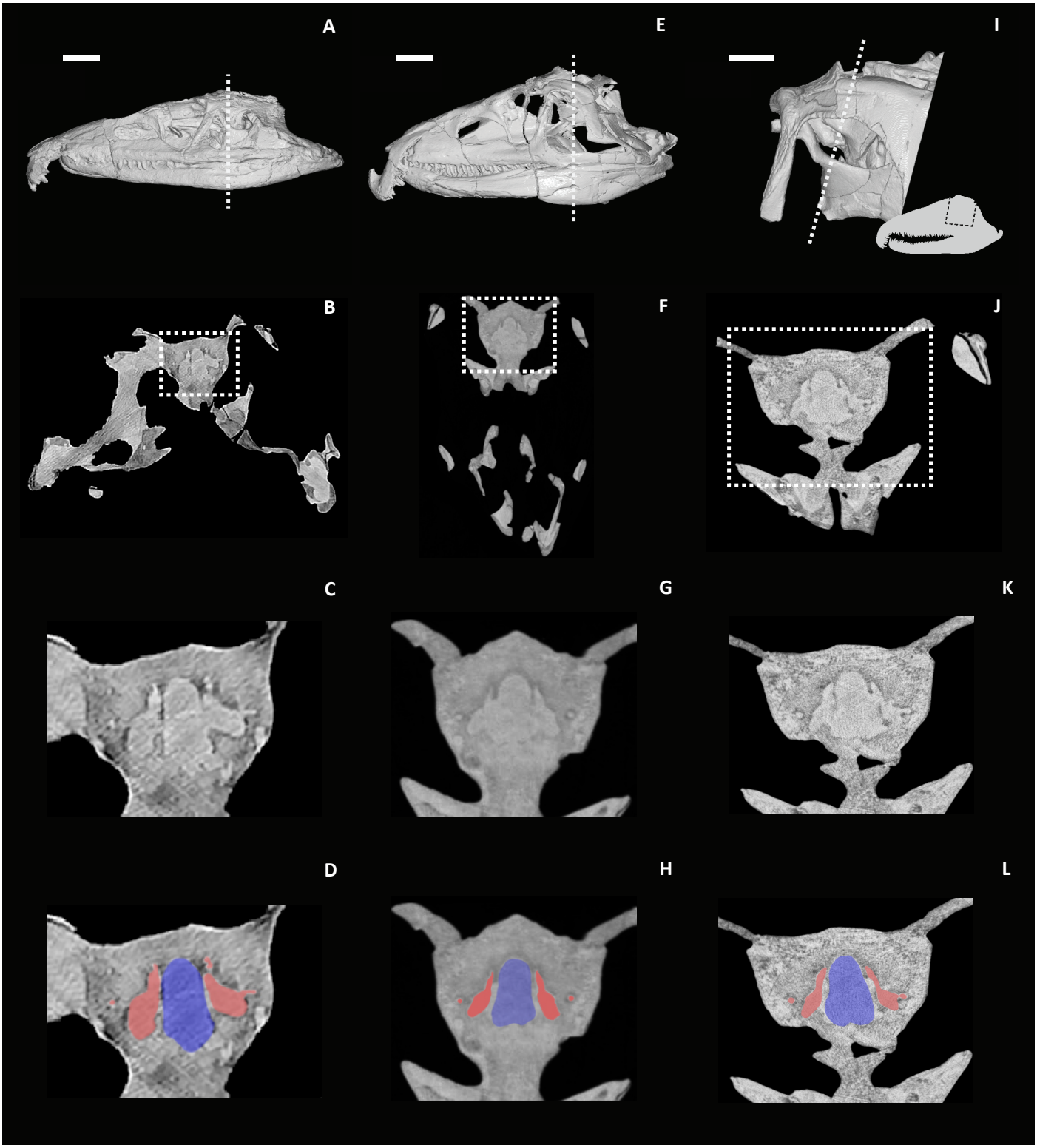

FIG S1. Demonstrating endocranial virtual segmentation of *Proterosuchus fergusi* specimens in SPIERSedit. A-D, SNSB-BSPG 1934 VIII 514; E-H, RC 846; I-L, RC 846 µCT (reversed). First row (A, E, I), virtual reconstruction of specimens from CT data in left lateral view. Weak smoothing applied to reconstructions in SpiersView. Scale bars: 50mm (A, E), 30mm (I). Second row (B, F, J), slice through the cranial cavity. Slice position indicated by grey line in respective first row figure. Third row (C, G, K), zoomed in view of the endocranial anatomy within the slice shown in respective second row figure. Fourth row (D, H, L), an example of segmenting the cranial cavity (blue) and endosseous labyrinths (red). Chosen slices demonstrate the maximum ventral extension of the endosseous labyrinths.

TABLE S1. Comparative taxa used in the morphometric analyses of this study along with ecological and phylogenetic grouping designation and source.

Abbr.	Taxa		Ecological Group	Phylogenetic Group	References
Ac.at	*Acrocanthosaurus atokensis*	†	Terrestrial	Non-avian theropod	Franzosa & Rowe 2005
Ae.mo	*Aegypius monachus*		Terrestrial	Aves	Kawabe *et al.* 2013
Ah.pr	*Ahaetulla prasina*		Terrestrial	Squamata	Palci *et al.* 2017
Al.mi	*Alligator mississippiensis*		Semi-aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	George & Holliday 2013; Brusatte *et al.* 2016
*Al.mi**	*Alligator mississippiensis* (prenatal)		Semi-aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Dufeau & Witmer 2015
Al.ko	*Allkaruen koi*	†	Terrestrial	Pterosauria	Codorniú *et al.* 2016
Al.fr	*Allosaurus fragilis*	†	Terrestrial	Non-avian theropod	Rogers 1998; Witmer & Ridgely 2009
Am.ca	*Amargasaurus cazaui*	†	Terrestrial	Sauropodomorpha	Witmer & Ridgely 2009
Am.cr	*Amblyrhynchus cristatus*		Semi-aquatic	Squamata	Neenan *et al* . 2017
An.or	*Anchiceratops ornatus*	†	Terrestrial	Ornithischia	Hopson 1979
An.sa	*Anhanguera santanae*	†	Terrestrial	Pterosauria	Witmer *et al.* 2003
An.hy	*Anodorhynchus hyacinthinus*		Terrestrial	Aves	Carril *et al.* 2016
An.wi	*Antarctosaurus wichmannianus*	†	Terrestrial	Sauropodomorpha	Paulina-Carabajal 2012
Ap.fo	*Aptenodytes fosteri*		Semi-aquatic	Aves	Georgi & Sipla 2008
Ap.pa	*Aptenodytes patagonicus*		Semi-aquatic	Aves	Ksepka *et al.* 2012
Ar.li	*Archaeopteryx lithographica*	†	Terrestrial	Aves	Alonso *et al.* 2004
Au.ga	*Aucasaurus garridoi*	†	Terrestrial	Non-avian theropod	Paulina-Carabajal & Succar 2014
Au.ha	*Augustasaurus hagdorni*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017
Bo.re	*Bonatitan reigi*	†	Terrestrial	Sauropodomorpha	Paulina-Carabajal 2012; Knoll *et al.* 2012
Br	*Brachiosaurus sp.*	†	Terrestrial	Sauropodomorpha	Knoll & Schwarz-Wings 2009
Bu.vi	*Bubo virginianus*		Terrestrial	Aves	Witmer *et al.* 2008
Bu.bu	*Buteo buteo*		Terrestrial	Aves	Lautenschlager *et al.* 2013
Ca.cr	*Caiman crocodilus*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Jirak & Janacek 2017; Brusatte *et al* . 2016
Ca.ya	*Caiman yacare*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Bona & Paulina-Carabajal 2013
Ca.re	*Calabaria reinhardtii*		Terrestrial	Squamata	Palci *et al.* 2017
Ca.co	*Callawayasaurus colombiensis*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017
Ca.ni	*Caloenas nicobarica*		Terrestrial	Aves	Gold *et al.* 2016
Ca.le	*Camarasaurus lentus*	†	Terrestrial	Sauropodomorpha	Knoll *et al.* 2012
Ca.sa	*Carcharodontosaurus saharicus*	†	Terrestrial	Non-avian theropod	Larsson 2001
Ce.ma	*Ceratosaurus magnicornis*	†	Terrestrial	Non-avian theropod	Sampson & Witmer 2007
Ci.ci	*Ciconia ciconia*		Terrestrial	Aves	Benson *et al.* 2017
Ch.in	*Chalcophaps indica*		Terrestrial	Aves	Gold *et al.* 2016
Ch.ch	*Chelonoidis chilensis*		Terrestrial	Testudines	Paulina-Carabajal *et al.* 2017
Co.li	*Columba livia*		Terrestrial	Aves	Gold *et al.* 2016
Co.gr	*Conchoraptor gracilis*	†	Terrestrial	Non-avian theropod	Balanoff *et al.* 2014
Co	*Corythosaurus sp.*	†	Terrestrial	Ornithischia	Evans *et al.* 2009
Ci.ar	*Cricosaurus araucanensis*	†	Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Herrera *et al.* 2013
Cr.ac	*Crocodylus actus*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Brusatte *et al.* 2016
Cr.in	*Crocodylus intermedius*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Brusatte *et al.* 2016
Cr.jo	*Crocodylus johnstoni*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Brusatte *et al.* 2016
Cr.mo	*Crocodylus moreletii*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Brusatte *et al.* 2016
Cr.ni	*Crocodylus niloticus*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Jirak & Janacek 2017
Cr.pa	*Crocodylus palustris*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Georgi & Sipla 2008
Cr.se	*Crocodylus siamensis*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Kawabe *et al.* 2009
De.an	*Deinonychus antirrhopus*	†	Terrestrial	Non-avian theropod	Witmer & Ridgely 2009
De.sp	*Desmatosuchus spurensis*	†	Terrestrial	Pseudosuchian/Non-phytosaurian pseudosuchian	Hopson 1979
Di.sr	*Didunculus strigirostris*		Terrestrial	Aves	Gold *et al* . 2016
Di.lo	*Diplodocus longus*	†	Terrestrial	Sauropodomorpha	Witmer *et al* . 2008; Knoll *et al.* 2012
Eb.ne	*Ebrachosuchus neukami*	†	Semi-Aquatic	Pseudosuchian/Phytosauria	Lautenschlager & Butler 2016
Er.an	*Erlikosaurus andrewsi*	†	Terrestrial	Non-avian theropod	Lautenschlager *et al.* 2012
Eu.tu	*Euoplocephalus tutus*	†	Terrestrial	Ornithischia	Miyashita *et al* . 2011; Leahey *et al.* 2015
Eu.ca	*Euparkeria capensis*	†	Terrestrial	Non-archosaurian archosauriform	Sobral *et al.* 2016
Fa.ut	*Falcarius utahensis*	†	Terrestrial	Non-avian theropod	Lautenschlager *et al.* 2012
Ga.lu	*Gallicolumba luzonica*		Terrestrial	Aves	Gold *et al* . 2016
Ga.im	*Gavia immer*		Semi-Aquatic	Aves	Ksepka *et al* . 2012
Ga.ga	*Gavialis gangeticus*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Pierce *et al.* 2017; Georgi & Sipla 2008
Ga.gl	*Gallus gallus*		Terrestrial	Aves	Benson *et al.* 2017
Ge.ni	*Geochelone nigra*		Terrestrial	Testudines	Georgi & Sipla 2008
Gi.br	*Giraffatitan brancai*	†	Terrestrial	Sauropodomorpha	Knoll *et al.* 2012
Go.be	*Gopherus berlandieri*		Terrestrial	Testudines	Paulina-Carabajal *et al* . 2017
Go.li	*Gorgosaurus libratus*	†	Terrestrial	Non-avian theropod	Witmer & Ridgely 2009
Go.cr	*Goura cristata*		Terrestrial	Aves	Gold *et al* . 2016
He.is	*Herrerasaurus ischigualastensis*	†	Terrestrial	Non-avian theropod	Knoll *et al.* 2012
Hy.pl	*Hydrophis platurus*		Aquatic	Squamata	Palci *et al.* 2017
Hy.al	*Hypacrosaurus altispinus*	†	Terrestrial	Ornithischia	Evans *et al.* 2009
In.ga	*Incisivosaurus gauthieri*	†	Terrestrial	Non-avian theropod	Balanoff *et al* . 2009
Ja.se	*Jainosaurus septentrionalis*	†	Terrestrial	Sauropodomorpha	Knoll *et al.* 2012
Ki.be	*Kinixys belliana*		Terrestrial	Testudines	Paulina-Carabajal *et al.* 2017
Ku.ie	*Kunbarrasaurus ieversi*	†	Terrestrial	Ornithischia	Leahey *et al* . 2015
La	*Lambeosaurus sp.*	†	Terrestrial	Ornithischia	Evans *et al.* 2009
La.co	*Laticauda colubrina*		Aquatic	Squamata	Yi & Norell 2015
Le.ol	*Lepidochelys olivacea*		Aquatic	Testudines	Neenan *et al* . 2017
Li.mo	*Libonectes morgani*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017
Ly.au	*Lycodon aulicus*		Terrestrial	Squamata	Palci *et al.* 2017
Ma.tm	*Macrochelys temminckii*		Aquatic	Testudines	Georgi & Sipla 2008
Ma.tn	*Macroplata tenuiceps*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017

Ma.cr	*Majungasaurus crenatissimus*	†	Terrestrial	Non-avian theropod	Sampson & Witmer 2007
Ma.ca	*Massospondylus carinatus*	†	Terrestrial	Sauropodomorpha	Knoll *et al* . 2012; Neenan *et al.* 2018
Me.un	*Melopsittacus undulatus*		Terrestrial	Aves	Benson *et al* . 2017
Mi.ho	*Microleuides homalospondylus*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017
Mu.ba	*Murusraptor barrosaensis*	†	Terrestrial	Non-avian theropod	Paulina-Carabajal & Currie 2017
My.mo	*Myiopsitta monachus*		Terrestrial	Aves	Carril *et al* . 2016
My.ri	*Myron richardsonii*		Semi-Aquatic	Squamata	Palci *et al.* 2017
Na.si	*Naja siamensis*		Terrestrial	Squamata	Palci *et al.* 2017
Ni.ta	*Nigersaurus taqueti*	†	Terrestrial	Sauropodomorpha	Sereno *et al* . 2007; Knoll *et al* . 2012
No	*Nothosaurus sp.*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017
No.mc	*Nothronychus mckinleyi*	†	Terrestrial	Non-avian theropod	Lautenschlager *et al.* 2012
Od.to	*Odontopteryx toliapica*	†	Terrestrial	Aves	Milner & Walsh 2009
Pa.mi	*Panoplosaurus mirus*	†	Terrestrial	Ornithischia	Witmer & Ridgely 2008
Pp.an	*Paraptenodytes antarcticus*	†	Semi-Aquatic	Aves	Ksepka *et al.* 2012
Pa.an	*Parasuchus angustifrons*	†	Semi-Aquatic	Pseudosuchian/Phytosauria	Lautenschlager & Butler 2016
Pa.hi	*Parasuchus hislopi*	†	Semi-Aquatic	Pseudosuchian/Phytosauria	Lautenschlager & Butler 2016
Pa.gr	*Parringtonia gracilis*	†	Terrestrial	Pseudosuchian/Non-phytosaurian pseudosuchian	Nesbitt *et al.* 2018
Pa.ca	*Pawpawsaurus campbelli*	†	Terrestrial	Ornithischia	Paulina-Carabajal *et al.* 2016
Pe.ty	*Pelagosaurus typus*	†	Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Pierce *et al* . 2017
Pe.ph	*Peloneustes philarchus*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017
Pe.so	*Pezophaps solitaria*	†	Terrestrial	Aves	Gold *et al.* 2016
Ph.ru	*Phaethon rubricauda*		Terrestrial	Aves	Milner & Walsh 2009
Ph.ch	*Phaps chalcoptera*		Terrestrial	Aves	Gold *et al.* 2016
Ph.im	*Phoebastria immutabilis*		Semi-Aquatic	Aves	Gold *et al.* 2016
Ph.me	*Pholidosaurus engelhardti*	†	Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Hopson 1979
Pi.ma	*Pionus maximiliani*		Terrestrial	Aves	Carril *et al* . 2016
Pl.gi	*Placodus gigas*	†	Aquatic	Sauropterygia	Neenan & Scheyer 2012
Pl.en	*Plateosaurus engelhardti*	†	Terrestrial	Sauropodomorpha	Galton 1985
Pl.me	*Plioplatecarpus meyeri*	†	Aquatic	Squamata	Neenan *et al* . 2017
Pr.sh	*Prophaethon shrubsolei*	†	Terrestrial	Aves	Milner & Walsh 2009
Pr.fe	*Proterosuchus fergusi*	†	Terrestrial	Non-archosaurian archosauriform	This study
Pr.gr	*Protoceratops grangeri*	†	Terrestrial	Ornithischia	Hopson 1979
Ps.ba	*Pseudogonatodes barbouri*		Terrestrial	Squamata	Bauer *et al* . 2018
Ps.er	*Psittacus erithacus*		Terrestrial	Aves	Benson *et al* . 2017
Ps.mc	*Pseudopalatus mccauleyi*	†	Semi-Aquatic	Pseudosuchian/Phytosauria	Holloway *et al.* 2013
Pt.mu	*Ptyas mucosa*		Terrestrial	Squamata	Yi & Norell 2015
Pu.ca	*Puppigerus camperi*	†	Aquatic	Testudines	Neenan *et al* . 2017
Py.an	*Pygoscelius antarcticus*		Semi-Aquatic	Aves	Gold *et al.* 2016
Ra.cu	*Raphus cucullatus*	†	Terrestrial	Aves	Gold *et al.* 2016
Rh.mu	*Rhamphorhynchus muensteri*	†	Terrestrial	Pterosauria	Witmer *et al.* 2003
Rh.fu	*Rhinoclemmys funerea*		Semi-Aquatic	Testudines	Paulina-Carabajal *et al.* 2017
Ri.te	*Riojasuchus tenuisceps*	†	Terrestrial	Pseudosuchian/Non-phytosaurian pseudosuchian	von Baczko & Desojo 2016
Se.ic	*Sebecus icaeorhinus*	†	Terrestrial	Pseudosuchian/Non-phytosaurian pseudosuchian	Hopson 1979
Sh.cr	*Shinisaurus crocodilurus*		Semi-Aquatic	Squamata	Digimorph
Sh.in	*Shuvosaurus inexpectatus*	†	Terrestrial	Pseudosuchian/Non-phytosaurian pseudosuchian	Holloway *et al* . 2013
Si.ga	*Simosaurus gaillardoti*	†	Aquatic	Sauropterygia	Neenan *et al* . 2017
Si.cl	*Simosuchus clarki*	†	Terrestrial	Pseudosuchian/Non-phytosaurian pseudosuchian	Kley *et al.* 2010
Sm.gr	*Smilosuchus gregorii*	†	Semi-Aquatic	Pseudosuchian/Phytosauria	Camp 1930
Sp.hu	*Spheniscus humboldti*		Semi-Aquatic	Aves	Paulina-Carabajal *et al.* 2014
Sp.ni	*Sphinophorosaurus nigerensis*	†	Terrestrial	Sauropodomorpha	Knoll *et al* . 2012
St.st	*Stegosaurus stenops*	†	Terrestrial	Ornithischia	Leahey *et al.* 2015
St.gr	*Steneosaurus gracilirostris*	†	Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Brusatte *et al.* 2016
St.ca	*Struthio camelus*		Terrestrial	Aves	Balanoff *et al.* 2013; Georgi & Sipla 2008
St.al	*Struthiomimus altus*	†	Terrestrial	Non-avian theropod	Witmer & Ridgely 2009
Te.gr	*Testudo graeca*		Terrestrial	Testudines	Paulina-Carabajal *et al.* 2017
Te.he	*Testudo hermanni*		Terrestrial	Testudines	Paulina-Carabajal *et al.* 2017
To.sc	*Tomistoma schlegelii*		Semi-Aquatic	Pseudosuchian/Non-phytosaurian pseudosuchian	Brusatte *et al.* 2016
Tr.ro	*Tropidosuchus romeri*	†	Semi-Aquatic	Non-archosaurian archosauriform	Trotteyn & Paulina-Carabajal 2016
Ty.al	*Tyto alba*		Terrestrial	Aves	Benson *et al.* 2017
Ty.ne	*Tylosaurus neopaeolicus*	†	Aquatic	Squamata	Georgi & Sipla 2008
Ty.re	*Tyrannosaurus rex*	†	Terrestrial	Non-avian theropod	Witmer & Ridgely 2009
Va.ex	*Varanus exanthematicus*		Terrestrial	Squamata	Evans 2016
Va.gi	*Varanus gilleni*		Terrestrial	Squamata	Palci *et al.* 2017
Va.ko	*Varanus komodoensis*		Terrestrial	Squamata	Georgi & Sipla 2008
Va.ni	*Varanus niloticus*		Semi-Aquatic	Squamata	Georgi & Sipla 2008
Va.sa	*Varanus salvator*		Semi-Aquatic	Squamata	Georgi & Sipla 2008
Vi.ex	*Viavenator exxoni*	†	Terrestrial	Non-avian theropod	Paulina-Carabajal & Filippi 2018
Xe.un	*Xenopeltis unicolor*		Terrestrial	Squamata	Yi & Norell 2015

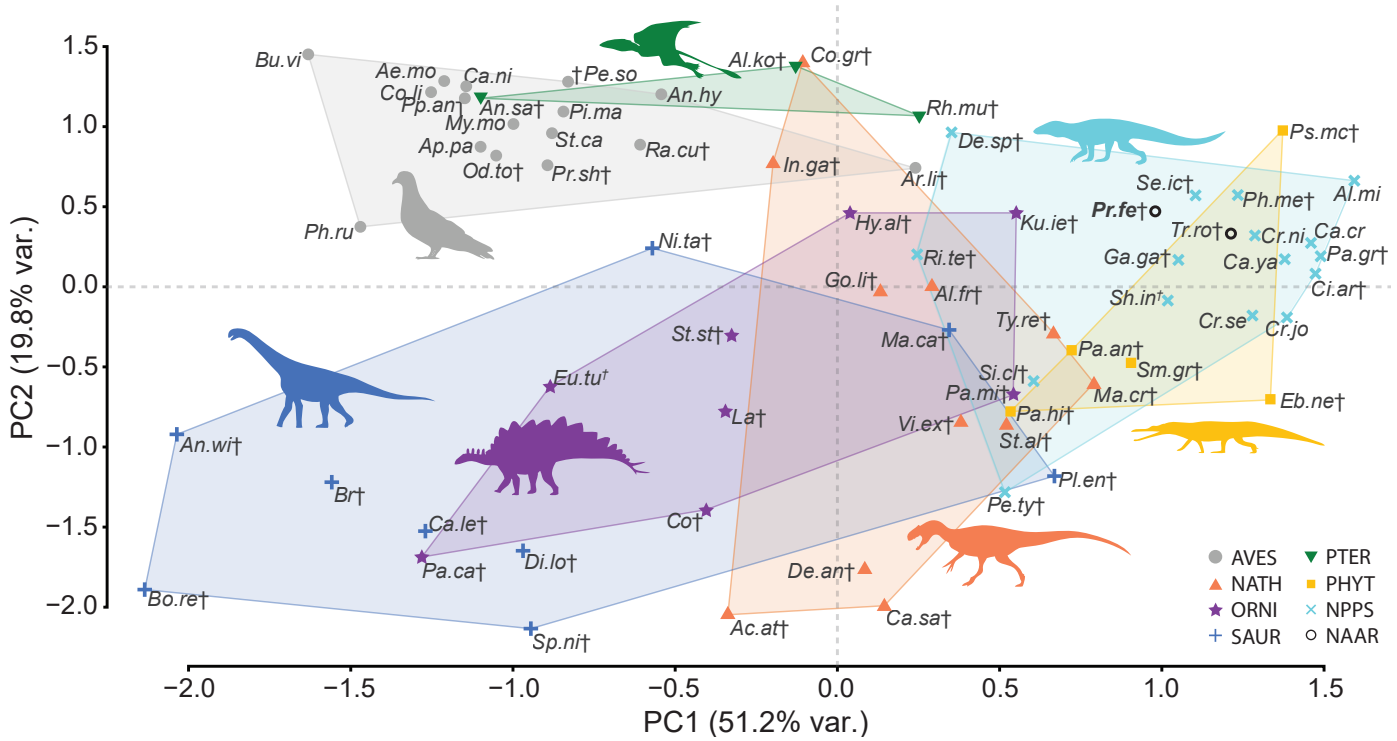

FIG S2. Repeat of Figure 4. Morphospace plots of archosauriform brain outlines based on elliptic Fourier analysis and after principal component analysis. PC1 vs. PC2. Abbreviations: NAAR, non-archosaurian archosauriform; NPPS, non-phytosaurian pseudosuchians; PHYT, Phytosauria; PTER, Pterosauria; SAUR, Sauropodomorpha; ORTH, Ornithischia; NATH, non-avian theropods; AVES, Aves. † denotes extinct taxa. Silhouettes used include work by S. Hartman, M. Witton, N. Tamura and T. M. Keesey (see http://phylopic.org for full licensing information).

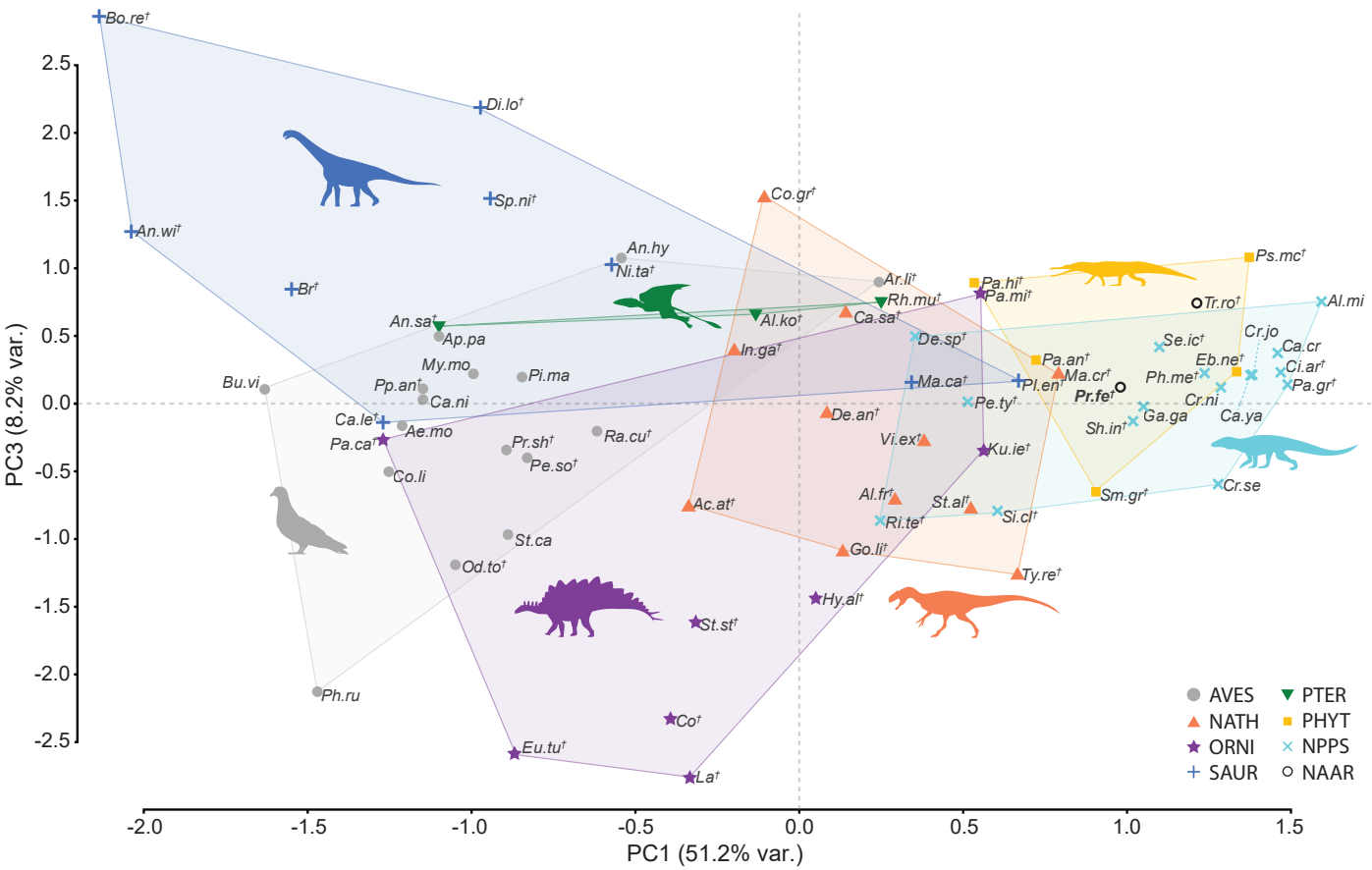

FIG S3. Morphospace plots of archosauriform brain outlines based on elliptic Fourier analysis and after principal component analysis. PC1 vs. PC3. Abbreviations: See Fig. S2. † denotes extinct taxa.

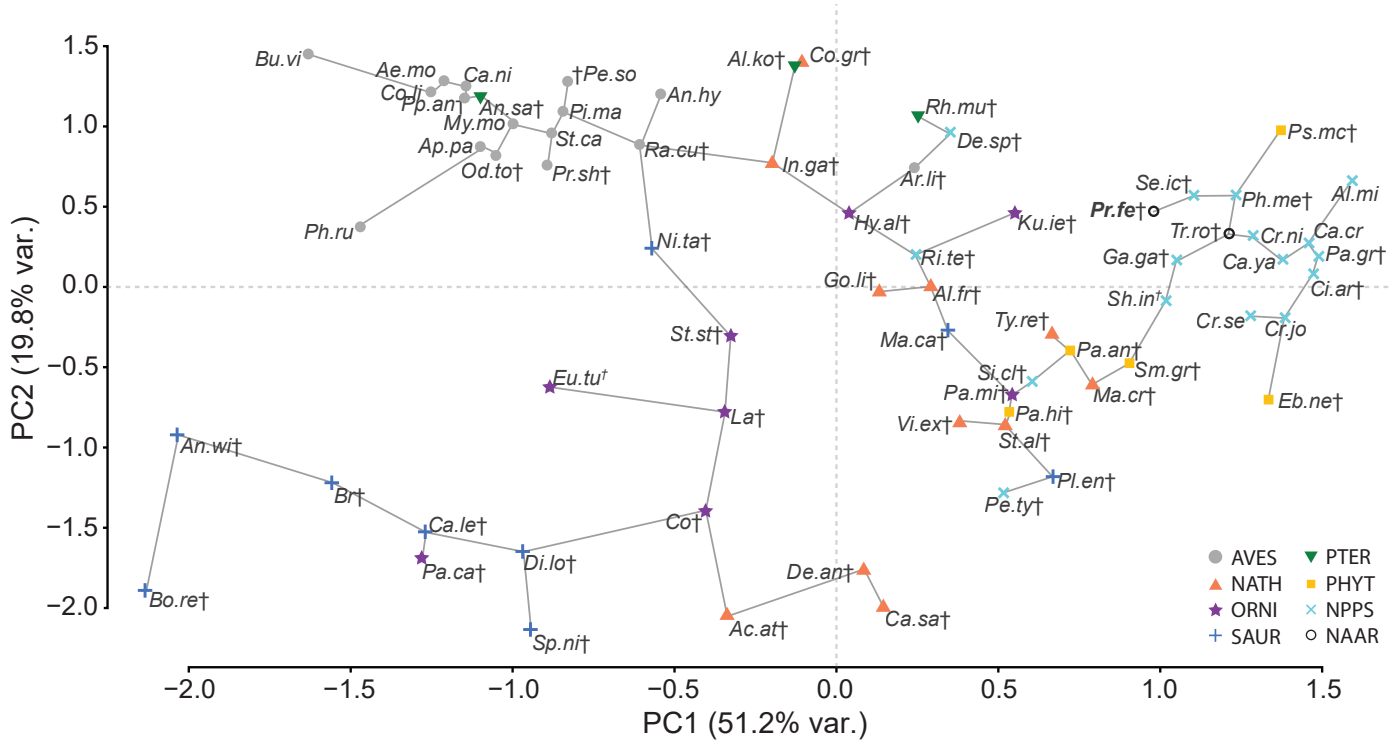

FIG S4. Related to Figure 4. Morphospace plots of archosauriform brain outlines based on elliptic Fourier analysis and after principal component analysis. PC1 vs. PC2. Black lines represent the minimum spanning tree. Abbreviations: See Fig. S2. † denotes extinct taxa.

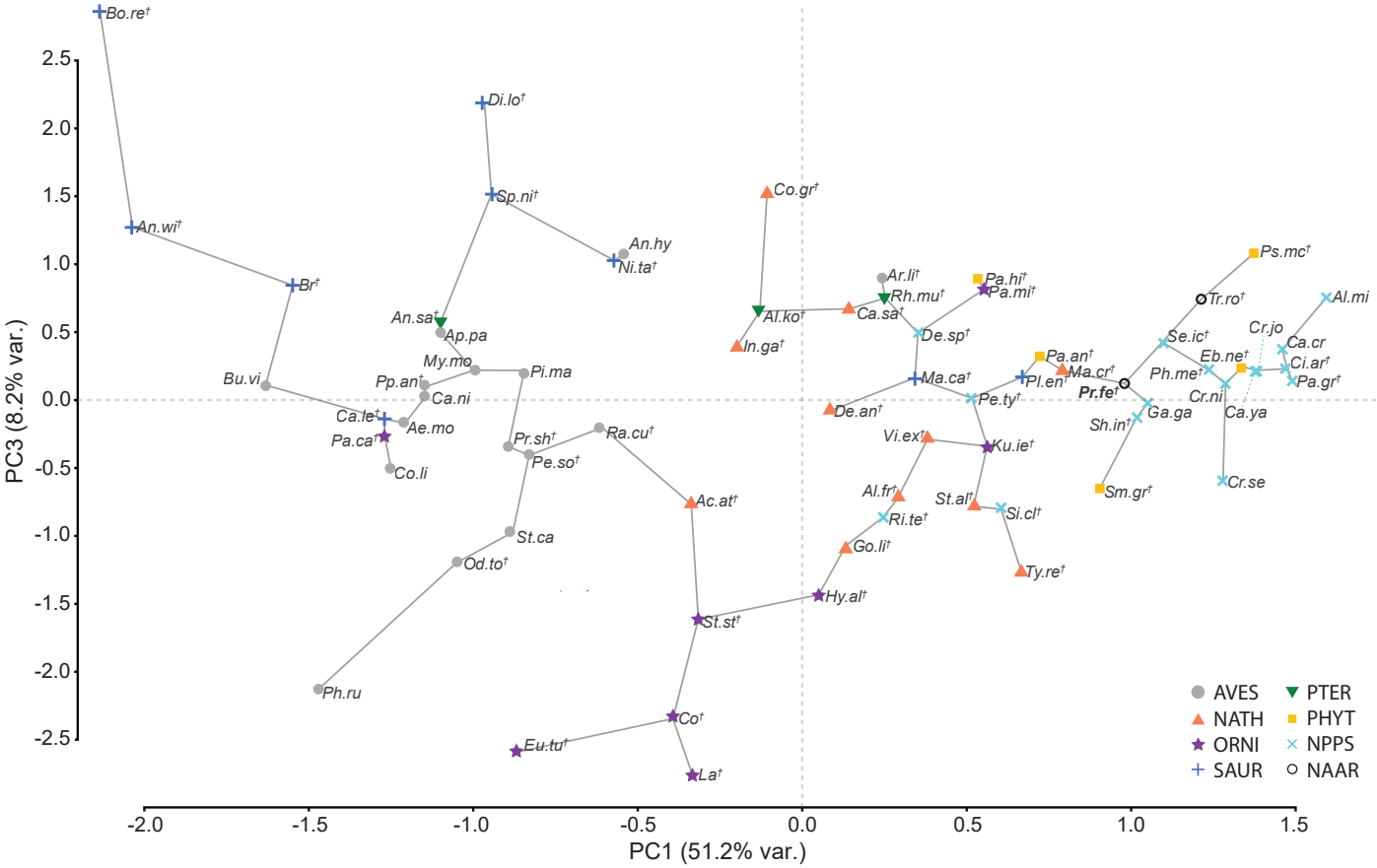

FIG S5. Morphospace plots of archosauriform brain outlines based on elliptic Fourier analysis and after principal component analysis. PC1 vs. PC3. Black lines represent the minimum spanning tree. Abbreviations: See Fig. S2. † denotes extinct taxa.

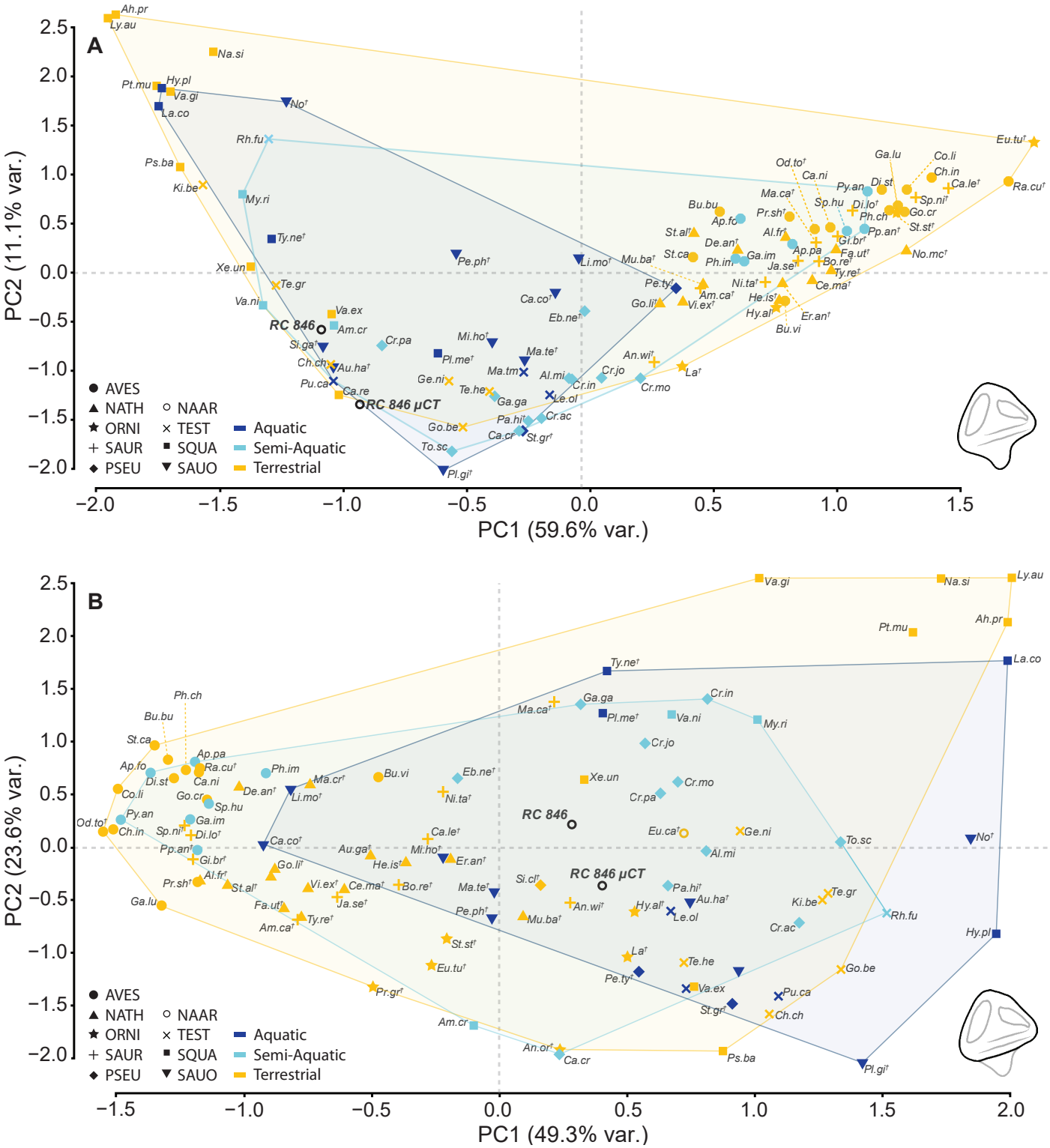

FIG S6. Related to Figure 5. Morphospace plots of avian and reptile inner ear outlines based on elliptic Fourier analysis and after principal component analysis, both with and without the endosseous cochlear duct (ECD). (A) with ECD; (B) without ECD. Abbreviations: SQUA, Squamata; SAUO, Sauropterygia; TEST, Testudines; NAAR, non-archosaurian archosauriform; PHYT, Phytosauria; NPPS, non-phytosaurian pseudosuchians; ORNI, Ornithischia; SAUR, Sauropodomorpha; NATH, non-avian theropods; AVES, Aves. † denotes extinct taxa.

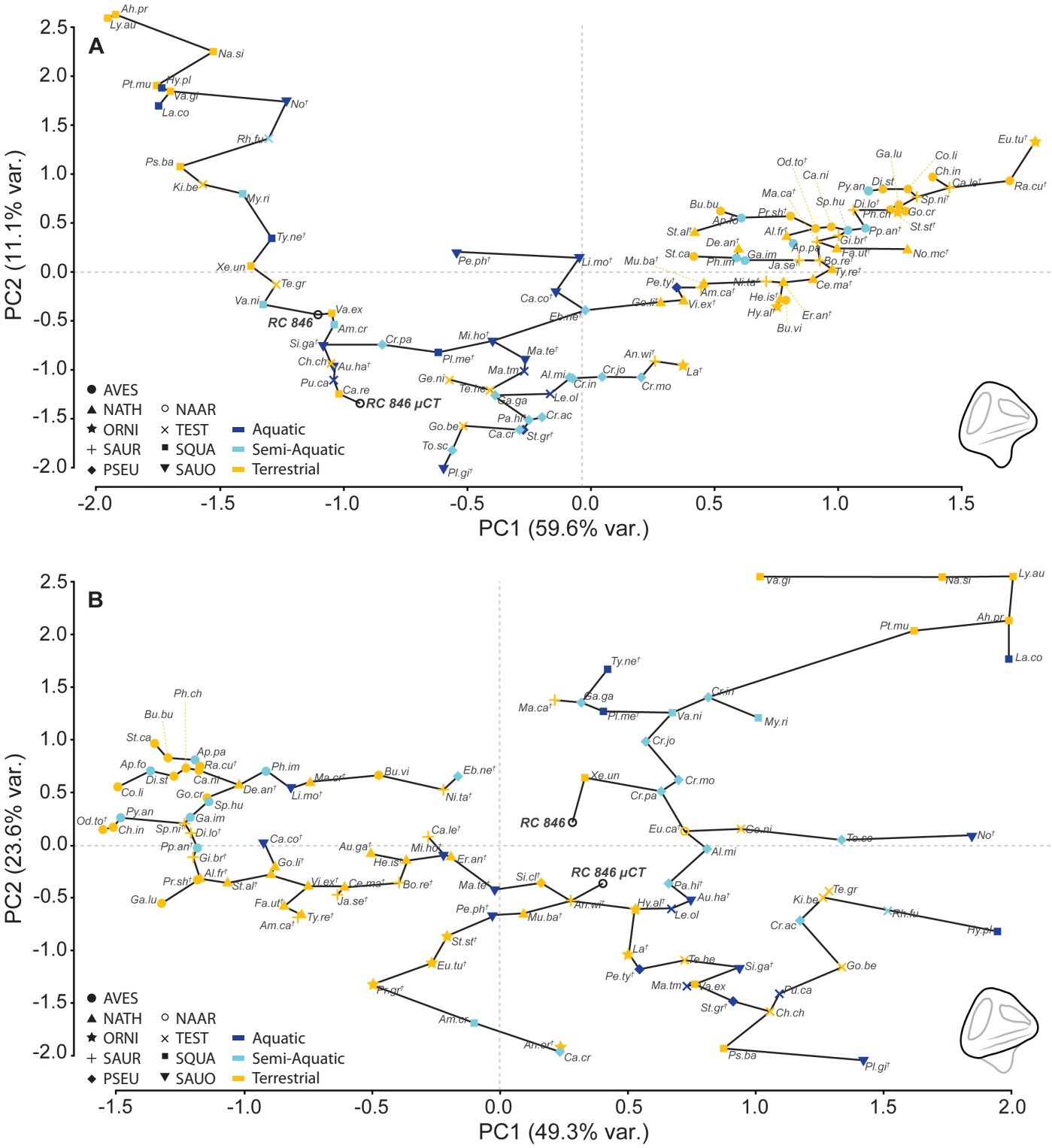

FIG S7. Related to Figure 5. Morphospace plots of avian and reptile inner ear outlines based on elliptic Fourier analysis and after principal component analysis, both with and without the endosseous cochlear duct (ECD). (A) with ECD; (B) without ECD. Black lines represent the minimum spanning tree. Abbreviations: See Fig. S6. † denotes extinct taxa.

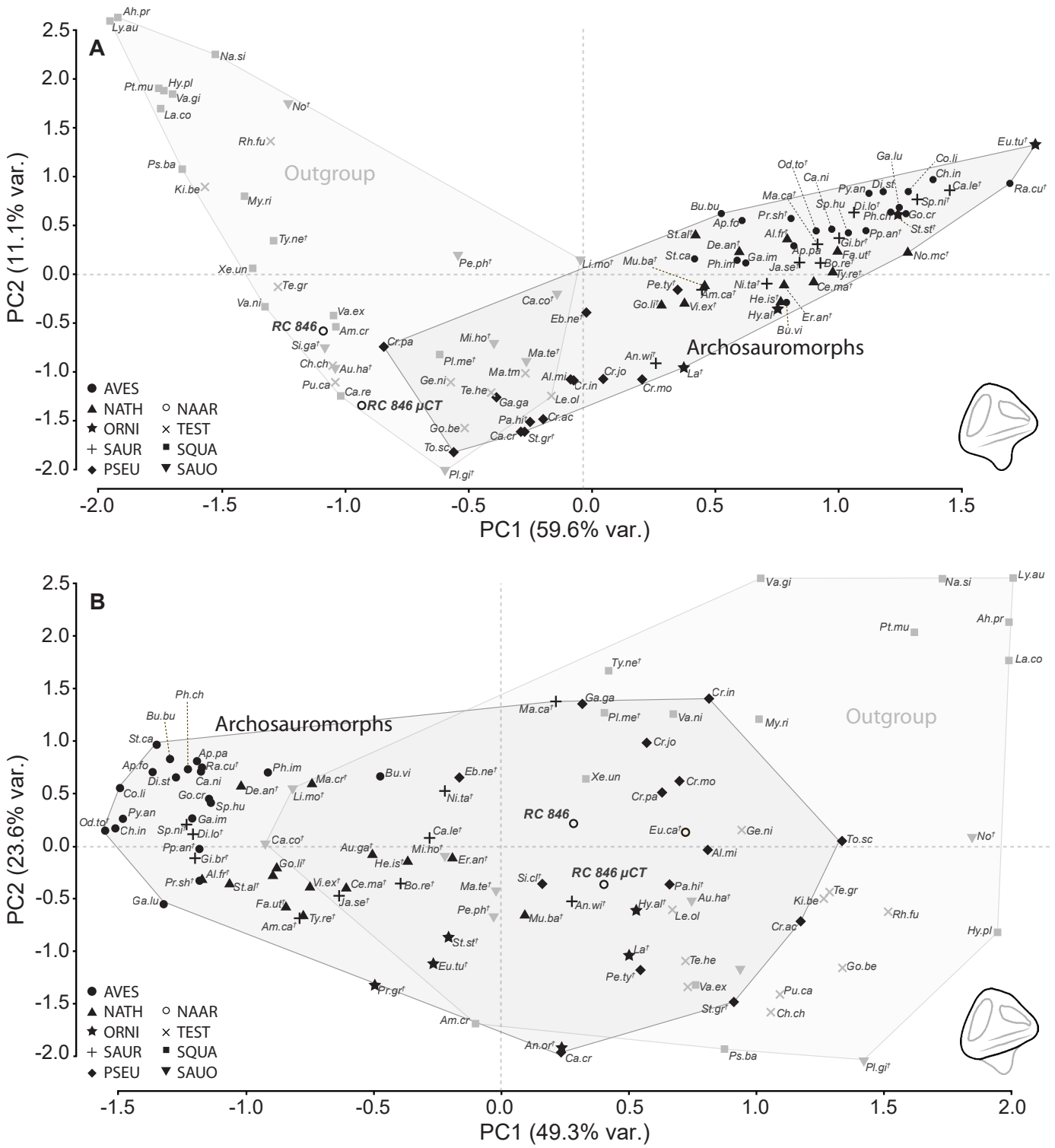

FIG S8. Related to Figure 5. Morphospace plots of avian and reptile inner ear outlines based on elliptic Fourier analysis and after principal component analysis, both with and without the endosseous cochlear duct (ECD). Convex hulls indicate spread of archosauromorph taxa and non-archosauromorph taxa. (A) with ECD; (B) without ECD. Colour key: Outgroup (light gray); Archosauromorpha (dark gray). Abbreviations: See Fig. S6. † denotes extinct taxa.

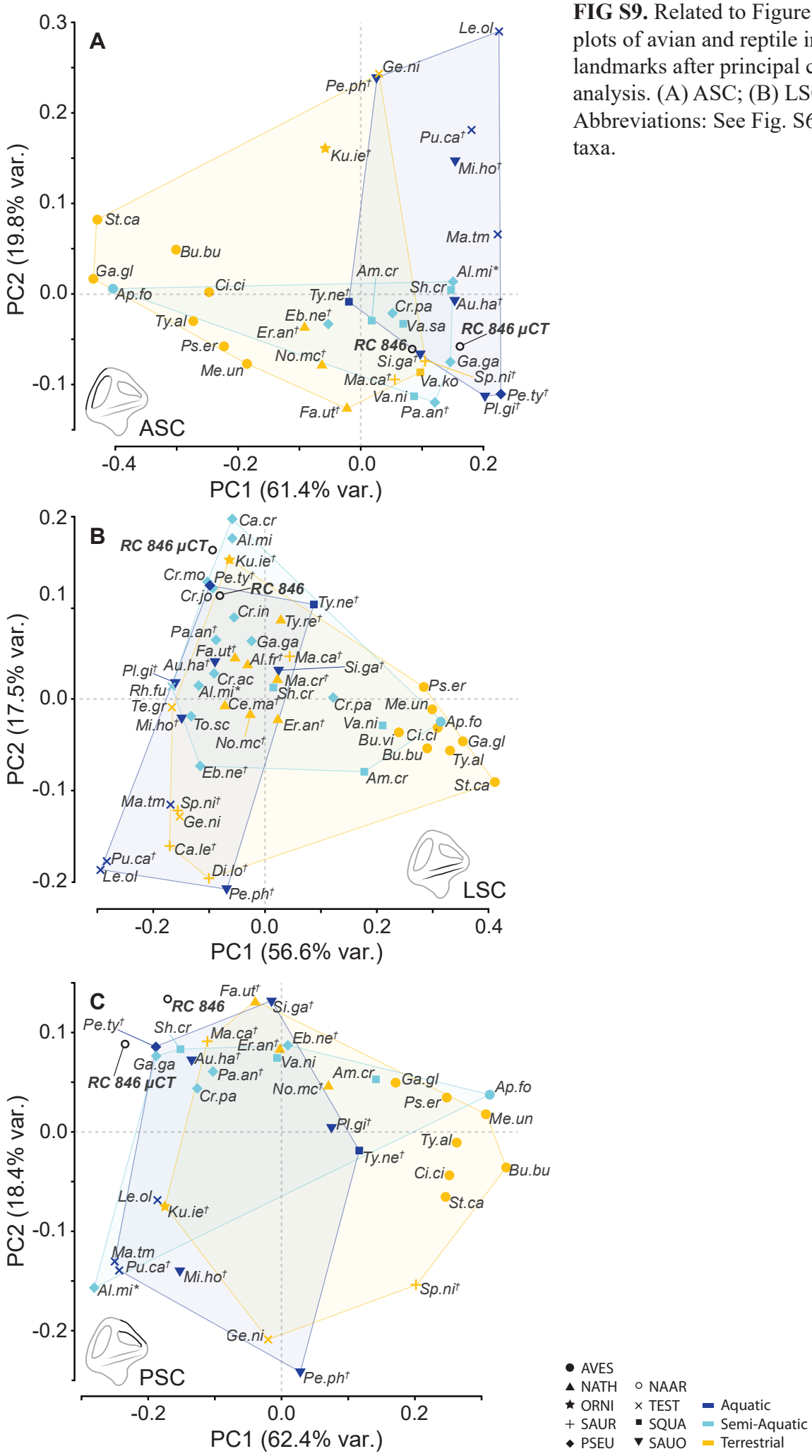

FIG S9. Related to Figure 6. Morphospace plots of avian and reptile inner ear 3D landmarks after principal component analysis. (A) ASC; (B) LSC; (C) PSC. Abbreviations: See Fig. S6. † denotes extinct taxa.

TABLE S2. Results of canonical variate analysis on semi-circular canal (ASC, LSC, PSC) landmarks between different saurian groups, using all axes. Permutation N = 10000. P-values in bold show statistical significance at p = 0.05. Abbreviations: ASC, anterior semi-circular canal; LSC, lateral semi-circular canal; PSC, posterior semi-circular canal.

ASC

p-values \ Procrustes	Squamata	Sauropterygia	Testudines	Non-archosaurian archosauriform	Pseudosuchia	Ornithischia	Sauropodomorpha	Non-avian theropods	Aves
Squamata		0.1549	0.2718	0.1241	0.1081	0.2514	0.0776	0.1410	0.3845
Sauropterygia	0.1705		0.1953	0.1485	0.1257	0.2959	0.1590	0.2477	0.4465
Testudines	**0.0275**	0.0970		0.2764	0.2648	0.2709	0.3022	0.3604	0.5197
Non-archosaurian archosauriform	0.1868	0.4665	0.0678		0.0979	0.3226	0.0900	0.2039	0.4479
Pseudosuchia	0.2049	0.2438	**0.0047**	0.4993		0.3184	0.0730	0.1803	0.4257
Ornithischia	0.2018	0.1689	0.1662	0.3295	0.1413		0.3088	0.2667	0.3443
Sauropodomorpha	0.6883	0.4018	0.0640	0.6694	0.8903	0.3353		0.1469	0.4066
Non-avian theropod	0.0803	**0.0170**	**0.0291**	0.0996	0.0573	0.2500	0.1984		0.2752
Aves	**0.0002**	**0.0013**	**0.0008**	**0.0231**	**0.0005**	0.0894	**0.0212**	**0.0102**	

LSC

p-values \ Procrustes	Squamata	Sauropterygia	Testudines	Non-archosaurian archosauriform	Pseudosuchia	Ornithischia	Sauropodomorpha	Non-avian theropods	Aves
Squamata		0.2293	0.3834	0.2585	0.2058	0.2573	0.2059	0.1676	0.2294
Sauropterygia	**0.0247**		0.2051	0.1931	0.1040	0.2226	0.1320	0.1556	0.4237
Testudines	**0.0004**	0.0870		0.3237	0.2617	0.3525	0.2111	0.2652	0.5646
Non-archosaurian archosauriform	0.1202	0.4689	0.0567		0.1497	0.0593	0.1940	0.1726	0.4602
Pseudosuchia	**0.0151**	0.6395	**0.0039**	0.1803		0.1778	0.1402	0.1349	0.3939
Ornithischia	0.2053	0.6510	0.2012	1.0000	0.5735		0.2041	0.1793	0.4512
Sauropodomorpha	0.1919	0.8549	0.2529	0.3329	0.3779	0.6671		0.0754	0.3989
Non-avian theropod	0.0871	0.3358	**0.0221**	0.1981	0.1598	0.3412	0.9343		0.3700
Aves	**0.0017**	**0.0012**	**0.0001**	**0.0208**	**0.0002**	0.1085	**0.0202**	**0.0049**	

PSC

p-values \ Procrustes	Squamata	Sauropterygia	Testudines	Non-archosaurian archosauriform	Pseudosuchia	Ornithischia	Sauropodomorpha	Non-avian theropods	Aves
Squamata		0.1394	0.2814	0.2485	0.2044	0.2454	0.1181	0.1041	0.2675
Sauropterygia	0.4363		0.1801	0.2356	0.1337	0.1658	0.1273	0.1367	0.3116
Testudines	0.0509	0.2031		0.2558	0.1856	0.0966	0.2638	0.2970	0.4649
Non-archosaurian archosauriform	0.1284	0.1376	0.0692		0.1369	0.2036	0.3028	0.2338	0.4891
Pseudosuchia	**0.0246**	0.2718	**0.0403**	0.3830		0.1511	0.2233	0.1690	0.4161
Ornithischia	0.0986	0.9964	0.9821	0.3223	0.5659		0.2463	0.2594	0.4560
Sauropodomorpha	0.7675	0.7952	0.1354	0.3314	0.1338	1.0000		0.1479	0.2488
Non-avian theropod	0.4206	0.4651	**0.0229**	0.0992	0.0885	0.2575	0.6985		0.2772
Aves	**0.0018**	**0.0007**	**0.0027**	**0.0211**	**0.0004**	0.1038	**0.0450**	**0.0009**	

TABLE S3. Sensitivity data for comparative taxa used in the analysis of auditory capabilities. Includes abbreviations used in Fig. S9.

Abbr.	Taxa	Ecological Group	Phylogenetic Group	Scaled ECD Length	Mean Hearing (Hz)	Hearing Range Difference (Hz)	References
Al.mi	*Alligator mississippiensis*	Semi-Aquatic	Crocodylia	0.1821	550	900	Walsh *et al.* 2009
An.sg	*Anolis sagrei*	Terrestrial	Squamata	0.1631	1100	1800	Walsh *et al.* 2009
Ap.ma	*Apteryx mantelli*	Terrestrial	Aves	0.2828	3200	5600	Walsh et al. 2009; Corfield *et al.* 2011
Ca.cr	*Caiman crocodilus*	Semi-Aquatic	Crocodylia	0.2366	1150	1700	Walsh *et al.* 2009
Ch.my	*Chelonia mydas*	Aquatic	Testudines	0.0841	325	350	Walsh *et al.* 2009
Ch.oc	*Chalcides occelatus*	Terrestrial	Squamata	0.1912	1150	1700	Walsh *et al.* 2009
Ch.se	*Chelydra serpenta*	Semi-Aquatic	Testudines	0.0910	800	600	Walsh *et al.* 2009
Co.co	*Corvus corax*	Terrestrial	Aves	0.6266	2550	4900	Walsh *et al.* 2009
Cr.ac	*Crocodylus acutus*	Semi-Aquatic	Crocodylia	0.0992	1650	2700	Walsh *et al.* 2009
Di.za	*Diplometopon zarudnyi*	Terrestrial	Squamata	0.2346	800	800	Walsh *et al.* 2009
Dr.no	*Dromaius novaehollandiae*	Terrestrial	Aves	0.2563	1790	3420	Walsh *et al.* 2009
Ga.ga	*Gavialis gangeticus*	Semi-Aquatic	Crocodylia	0.1494	690	1980	Walsh et al. 2009; Bonke *et al.* 2015
Ga.wi	*Gambelia wislizenii*	Terrestrial	Squamata	0.1605	500	400	Walsh *et al.* 2009
Ge.ge	*Gekko gecko*	Terrestrial	Squamata	0.2210	2610	4780	Walsh *et al.* 2009
He.ca	*Hemitheconyx caudicinctus*	Terrestrial	Squamata	0.2054	1010	1580	Walsh *et al.* 2009
Me.un	*Melopsittacus undulatus*	Terrestrial	Aves	0.3094	3650	6700	Walsh *et al.* 2009
Po.si	*Podarcis sicula*	Terrestrial	Squamata	0.1834	1750	2500	Walsh *et al.* 2009
Pt.ha	*Ptyodactylus hasselquistii*	Terrestrial	Squamata	0.2040	1400	2200	Walsh *et al.* 2009
Sp.de	*Spheniscus demersus*	Semi-Aquatic	Aves	0.2463	2300	3400	Walsh *et al.* 2009
Sp.pu	*Sphenodon punctatus*	Terrestrial	Rhynchocephalia	0.1964	450	700	Walsh *et al.* 2009
Ta.gu	*Taeniopygia guttata*	Terrestrial	Aves	0.5504	3350	4700	Walsh *et al.* 2009
Ti.ru	*Tiliqua rugosa*	Terrestrial	Squamata	0.1469	2100	3800	Walsh *et al.* 2009
To.sc	*Tomistoma schlegelii*	Semi-Aquatic	Crocodylia	0.1841	970	3030	Walsh et al. 2009; Bonke *et al.* 2015
Ty.al	*Tyto alba*	Terrestrial	Aves	0.8929	5000	9000	Walsh *et al.* 2009
Ur.ha	*Uromastyx hardwickii*	Terrestrial	Squamata	0.1271	1650	2700	Walsh *et al.* 2009
Va.ni	*Varanus niloticus*	Semi-Aquatic	Squamata	0.0869	950	1100	Walsh *et al.* 2009

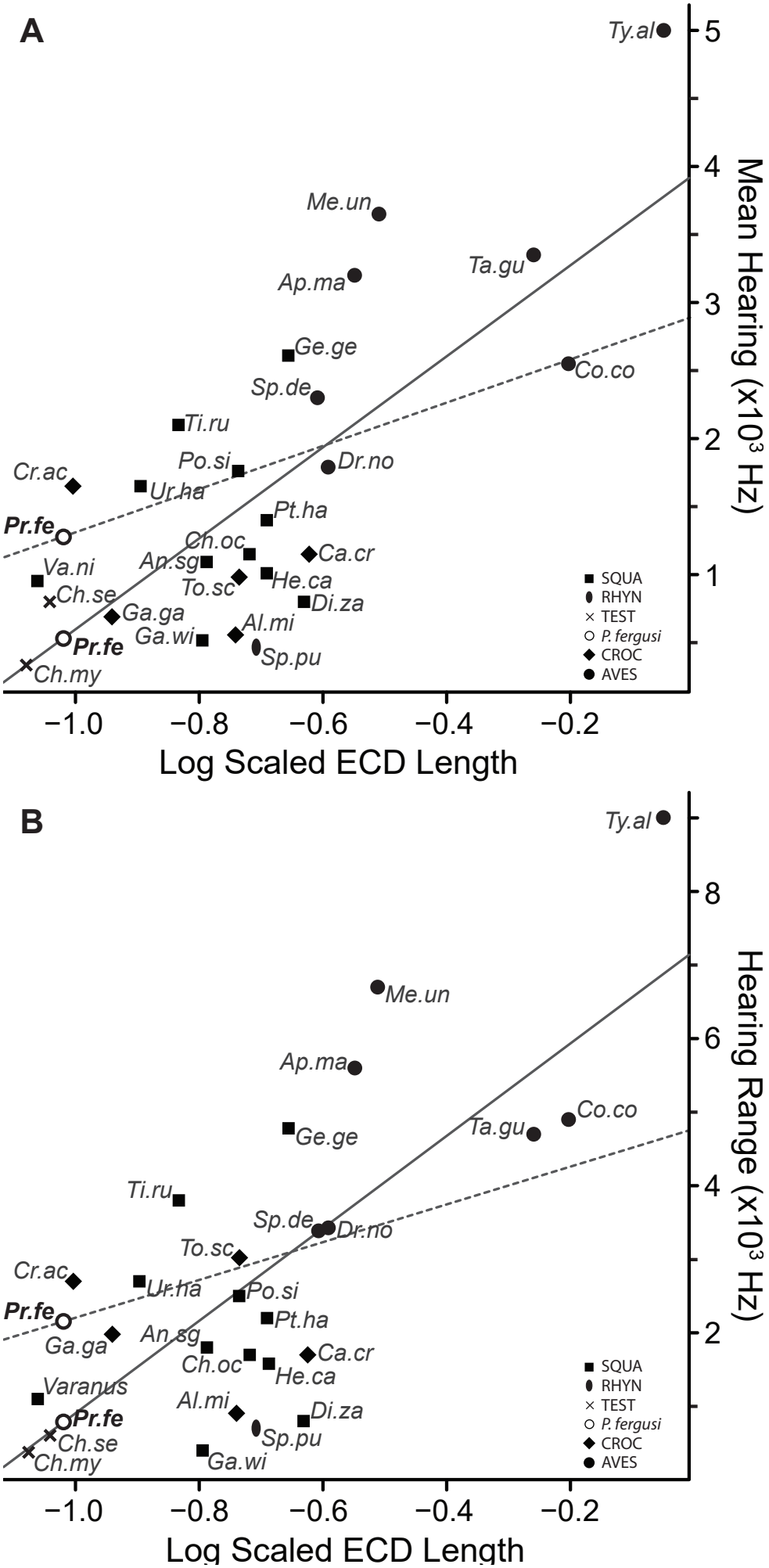

FIG S10. Correlation plot between scaled/log transformed ECD length and variables of hearing sensitivity for extant reptiles and Aves. Both a linear regression (solid line) and PGLS regression (dashed line) were used to estimate the auditory capabilities of *Proterosuchus fergusi*. Sensitivity variables: (A) mean hearing frequency; (B) hearing range. Abbreviations: SQUA, Squamata; RHYN, Rhynchocephalia; TEST, Testudines; CROC, Crocodylomorpha; AVES, Aves.

TABLE S4. Results of two tailed paired t-tests in the resistance to dorsoventral bending (lx), mediolateral bending (ly), and torsion (J) between *Proterosuchus fergusi* and comparative taxa for both the whole rostrum (left) and first 20% of the rostrum (right). In *Proterosuchus fergusi*, both a straight beam and a curved beam were used when analysing the anterior 20% of the rostrum. Results in bold show statistical significance at p = 0.05.

	Straight beam								Curved beam							
	Whole rostrum				First 20% of rostrum				Whole rostrum				First 20% of rostrum			
	True size		Scaled size		True size		Scaled size		True size		Scaled size		True size		Scaled size	
	t	p-value	t	p-value	t	p-value	t	p-value	t	p-value	t	p-value	t	p-value	t	p-value
lx																
P. fergusi/A. spatula	**2.6179**	**0.0129**	**2.4575**	**0.0189**	**4.6431**	**0.0002**	**3.4588**	**0.0025**	**2.9059**	**0.0067**	**2.7635**	**0.0095**	**6.4911**	**<0.0001**	2.0037	0.0635
P. fergusi/A. mississippiensis	**2.6135**	**0.0130**	**2.5477**	**0.0153**	**4.6291**	**0.0002**	**4.3901**	**0.0003**	**2.9021**	**0.0068**	**2.8437**	**0.0078**	**6.2445**	**<0.0001**	1.7304	0.1041
P. fergusi/C. moreletii	**2.3089**	**0.0268**	1.9812	0.0553	**3.8190**	**0.0011**	**2.9363**	**0.0082**	**2.6291**	**0.0132**	**2.3292**	**0.0265**	1.8380	0.0859	**2.7911**	**0.0137**
P. fergusi/C. rhombifer	**2.1510**	**0.0383**	1.8257	0.0762	**3.6940**	**0.0014**	**3.0354**	**0.0065**	**2.4857**	**0.0185**	**2.1861**	**0.0365**	**2.5198**	**0.0236**	**3.3257**	**0.0046**
P. fergusi/T. schlegelii	**2.5987**	**0.0135**	**2.6022**	**0.0134**	**4.5921**	**0.0002**	**4.6017**	**0.0002**	**2.8889**	**0.0070**	**2.8921**	**0.0069**	**5.5145**	**0.0001**	**5.7088**	**<0.0001**
ly																
P. fergusi/A. spatula	**2.8184**	**0.0078**	0.2722	0.7871	**4.5685**	**0.0002**	1.7561	0.0944	**2.9573**	**0.0059**	0.6701	0.5077	**6.3255**	**<0.0001**	**2.9754**	**0.0094**
P. fergusi/A. mississippiensis	**2.6723**	**0.0112**	0.4542	0.6524	**4.1775**	**0.0005**	1.1770	0.2530	**2.8292**	**0.0081**	0.8390	0.4079	1.9446	0.0708	**3.9202**	**0.0014**
P. fergusi/C. moreletii	0.6642	0.5108	1.8702	0.0696	0.3089	0.7606	**2.1143**	**0.0472**	0.2653	0.7926	1.4218	0.1651	**3.3724**	**0.0042**	**3.7030**	**0.0021**
P. fergusi/C. rhombifer	1.2088	0.2346	1.9835	0.0550	0.7535	0.4599	**2.6463**	**0.0155**	0.7858	0.4380	1.5328	0.1355	**4.0086**	**0.0011**	**4.2331**	**0.0007**
P. fergusi/T. schlegelii	**2.6795**	**0.0110**	**2.7066**	**0.0103**	**4.4420**	**0.0003**	**4.4677**	**0.0002**	**2.8338**	**0.0080**	**2.8581**	**0.0076**	**4.8070**	**0.0002**	**5.1357**	**0.0001**
J																
P. fergusi/A. spatula	**2.7073**	**0.0103**	1.8043	0.0796	**4.7717**	**0.0001**	0.3438	0.7346	**2.9549**	**0.0059**	**2.1466**	**0.0398**	**6.4623**	**<0.0001**	**2.8892**	**0.0112**
P. fergusi/A. mississippiensis	**2.6603**	**0.0116**	1.9334	0.0611	**4.5927**	**0.0002**	1.6770	0.1091	**2.9134**	**0.0066**	**2.2636**	**0.0307**	**3.7460**	**0.0019**	**3.6476**	**0.0024**
P. fergusi/C. moreletii	1.2140	0.2327	0.0573	0.9546	**2.2734**	**0.0342**	0.0920	0.9276	1.5820	0.1238	0.3699	0.7140	**3.0988**	**0.0073**	**3.5725**	**0.0028**
P. fergusi/C. rhombifer	0.7228	0.4745	0.2918	0.7722	1.6008	0.1251	0.1870	0.8536	1.1165	0.2728	0.1445	0.8860	**3.8081**	**0.0017**	**4.1443**	**0.0009**
P. fergusi/T. schlegelii	**2.6532**	**0.0118**	**2.6634**	**0.0115**	**4.6857**	**0.0001**	**4.7026**	**0.0001**	**2.9068**	**0.0067**	**2.9159**	**0.0065**	**5.1735**	**0.0001**	**5.4458**	**0.0001**

APPENDIX REFERENCES

BACZKO, M. B. VON and DESOJO, J. B. 2016. Cranial anatomy and palaeoneurology of the archosaur *Riojasuchus tenuisceps* from the Los Colorados Formation, La Rioja, Argentina. *PLoS ONE*, **11**, e0148575.

BALANOFF, A. M., BEVER, G. S. and NORELL, M. A. 2014. Reconsidering the avian nature of the oviraptorosaur brain (Dinosauria: Theropoda). *PLoS One*, **9**, e113559.

BAUER, A. M., BEACH-MEHROTRA, M., BERMUDEZ, Y., CLARK, G. E., DAZA, J. D., GLYNNE, E., HAGYARI, D., HARNDEN, J. M., HOLOVACS, N., KANASIRO, A. and LOFTHUS, A. J. 2018. The Tiny Skull of the Peruvian Gecko *Pseudogonatodes barbouri* (Gekkota: Sphaerodactylidae) Obtained via a Divide-And-Conquer Approach to Morphological Data Acquisition. *South American Journal of Herpetology*, **13**, 102-116.

BENSON, R. B., STARMER-JONES, E., CLOSE, R. A. and WALSH, S. A. 2017. Comparative analysis of vestibular ecomorphology in birds. *Journal of anatomy*, **231**, 990-1018.

BONA, P. and PAULINA-CARABAJAL, A. 2013. *Caiman gasparinae sp. nov.,* a huge alligatorid (Caimaninae) from the late Miocene of Paraná, Argentina. *Alcheringa: An Australasian Journal of Palaeontology*, **37**, 462-473.

BONKE, R., WHITAKER, N., ROEDDER, D. and BOEHME, W. 2015. Vocalizations in two rare crocodilian species: A comparative analysis of distress calls of *Tomistoma schlegelii* (Müller, 1838) and *Gavialis gangeticus* (Gmelin, 1789). *North-Western Journal of Zoology*, **11**, 151–162.

BRUSATTE, S. L., MUIR, A., YOUNG, M. T., WALSH, S., STEEL, L. and WITMER, L. M. 2016. The braincase and neurosensory anatomy of an Early Jurassic marine crocodylomorph: implications for crocodylian sinus evolution and sensory transitions. The Anatomical Record, 299, 1511–1530.

CAMP, C. L. 1930. A study of the phytosaurs with description of new material from western North America. *Memoirs of the University of California*, **10**, 1–161

CARRIL, J., TAMBUSSI, C. P., DEGRANGE, F. J., BENITEZ SALDIVAR, M. J. and PICASSO, M. B. J. 2016. Comparative brain morphology of Neotropical parrots (Aves, Psittaciformes) inferred from virtual 3D endocasts. *Journal of anatomy*, **229**, 239-251.

CODORNIÚ, L., CARABAJAL, A. P., POL, D., UNWIN, D. and RAUHUT, O. W. 2016. A Jurassic pterosaur from Patagonia and the origin of the pterodactyloid neurocranium. *PeerJ*, **4**, e2311.

CORFIELD, J. R., KUBKE, M. F. and KÖPPL, C. 2013. Emu and kiwi: the ear and hearing in Paleognathous birds. 263–287. *In* KÖPPL, C., MANLEY, G. A., POPPER, A. N. and FAY, R. R. (eds). *Insights from comparative hearing research*. Springer, 388 pp.

DUFEAU, D. L. and WITMER, L. M. 2015. Ontogeny of the middle-ear air-sinus system in *Alligator mississippiensis* (Archosauria: Crocodylia). *PLoS One*, **10**, e0137060.

EVANS, D. C., RIDGELY, R. and WITMER, L. M. 2009. Endocranial anatomy of lambeosaurine hadrosaurids (Dinosauria: Ornithischia): a sensorineural perspective on cranial crest function. *The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology: Advances in Integrative Anatomy and Evolutionary Biology*, **292**, 1315-1337.

FRANZOSA, J. and ROWE, T. 2005. Cranial endocast of the Cretaceous theropod dinosaur *Acrocanthosaurus atokensis*. *Journal of Vertebrate Paleontology*, **25**, 859-864.

GALTON, P. M. 1985. Cranial anatomy of the prosauropod dinosaur *Plateosaurus* from the Knollenmergel (Middle Keuper, Upper Triassic) of Germany. *Geologica et Palaeontologica*, **19**, 119-159.

GEORGE, I. and HOLLIDAY, C. 2013. Trigeminal nerve morphology in Alligator mississippiensis and its significance for crocodyliform facial sensation and evolution. *The Anatomical Record*, **296**, 670-680.

GEORGI, J. A. and SIPLA, J. S. 2008. Comparative and functional anatomy of balance in aquatic reptiles and birds. 233–256. *In* THEWISSEN J. G. M. and NUMMELA S. (eds). *Sensory evolution on the threshold: Adaptations in secondarily aquatic vertebrates.* University of California Press, 358 pp.

GOLD, M. E. L., BOURDON, E. and NORELL, M. A. 2016. The first endocast of the extinct dodo (*Raphus cucullatus*) and an anatomical comparison amongst close relatives (Aves, Columbiformes). *Zoological Journal of the Linnean Society*, **177**, 950-963.

HERRERA, Y., GASPARINI, Z. and FERNANDEZ, M. S. 2013. A new Patagonian species of *Cricosaurus* (Crocodyliformes, Thalattosuchia): first evidence of *Cricosaurus* in Middle–Upper Tithonian lithographic limestone from Gondwana. *Palaeontology*, **56**, 663-678.

HOLLOWAY, W. L., CLAESON, K. M. and O'KEEFE, F. R. 2013. A virtual phytosaur endocast and its implications for sensory system evolution in archosaurs. *Journal of Vertebrate Paleontology*, **33**, 848–857.

HOPSON, J. A., 1979. Paleoneurology. 39-146. *In* GANS, C., BELLAIRS, A., and PARSONS, T. (eds). *Biology of the Reptilia vol. 9*, Academic Press, 373 pp.

JIRAK, D. and JANACEK, J. 2017. Volume of the crocodilian brain and endocast during ontogeny. *PLoS ONE*, **12**, e0178491.

KAWABE, S., SHIMOKAWA, T., MIKI, H., OKAMOTO, T. and MATSUDA, S., 2009. A simple and accurate method for estimating the brain volume of birds: possible application in paleoneurology. *Brain, behavior and evolution*, **74**, 295-301.

KAWABE, S., SHIMOKAWA, T., MIKI, H., MATSUDA, S. and ENDO, H. 2013. Variation in avian brain shape: relationship with size and orbital shape. *Journal of anatomy*, **223**, 495-508.

KLEY, N. J., SERTICH, J. J., TURNER, A. H., KRAUSE, D. W., O'CONNOR, P. M. and GEORGI, J. A. 2010. Craniofacial morphology of *Simosuchus clarki* (Crocodyliformes: Notosuchia) from the Late Cretaceous of Madagascar. *Journal of Vertebrate Paleontology*, **30**, 13–98.

KSEPKA, D. T., BALANOFF, A. M., WALSH, S., REVAN, A. and HO, A. 2012. Evolution of the brain and sensory organs in Sphenisciformes: new data from the stem penguin *Paraptenodytes antarcticus*. *Zoological Journal of the Linnean Society*, **166**, 202-219.

KNOLL, F., RIDGELY, R. C., ORTEGA, F., SANZ, J. L. and WITMER, L. M. 2012. Neurocranial osteology and neuroanatomy of a Late Cretaceous titanosaurian sauropod from Spain (*Ampelosaurus sp.*). *PLoS One*, **8**, e54991.

KNOLL, F. and SCHWARZ-WINGS, D. 2009. Palaeoneuroanatomy of *Brachiosaurus*. *Annales de paléontologie*, **95**, 165-175.

LARSSON, H. C. E. 2001. Endocranial anatomy of *Carcharodontosaurus saharicus* (Theropoda: Allosauroidea) and its implications for theropod brain evolution. *Mesozoic vertebrate life*, 19-33.

LAUTENSCHLAGER, S., RAYFIELD, E. J., ALTANGEREL, P., ZANNO, L. E. and WITMER, L. M. 2012. The endocranial anatomy of Therizinosauria and its implications for sensory and cognitive function. *PLoS One*, **7**, e52289.

LAUTENSCHLAGER, S., BRIGHT, J. A. and RAYFIELD, E. J. 2014. Digital dissection–using contrast-enhanced computed tomography scanning to elucidate hard-and soft-tissue anatomy in the Common Buzzard *Buteo buteo*. *Journal of Anatomy*, **224**, 412-431.

LAUTENSCHLAGER, S. and BUTLER, R. J., 2016. Neural and endocranial anatomy of Triassic phytosaurian reptiles and convergence with fossil and modern crocodylians. *PeerJ*, **4**, e2251.

LEAHEY, L. G., MOLNAR, R. E., CARPENTER, K., WITMER, L. M. and SALISBURY, S. W. 2015. Cranial osteology of the ankylosaurian dinosaur formerly known as *Minmi sp*. (Ornithischia: Thyreophora) from the Lower Cretaceous Allaru Mudstone of Richmond, Queensland, Australia. *PeerJ*, **3**, e1475.

MIYASHITA, T., ARBOUR, V. M., WITMER, L. M. and CURRIE, P. J. 2011. The internal cranial morphology of an armoured dinosaur *Euoplocephalus* corroborated by X-ray computed tomographic reconstruction. *Journal of Anatomy*, **219**, 661-675.

MILNER, A. C. and WALSH, S. A. 2009. Avian brain evolution: new data from Palaeogene birds (Lower Eocene) from England. *Zoological Journal of the Linnean Society*, **155**, 198-219.

NEENAN, J. M., REICH, T., EVERS, S. W., DRUCKENMILLER, P. S., VOETEN, D. F., CHOINIERE, J. N., BARRETT, P. M., PIERCE, S. E. and BENSON, R. B. 2017. Evolution of the sauropterygian labyrinth with increasingly pelagic lifestyles. *Current Biology*, **27**, 3852–3858.

NEENAN, J. M. and SCHEYER, T. M. 2012. The braincase and inner ear of *Placodus gigas* (Sauropterygia, Placodontia)—a new reconstruction based on micro-computed tomographic data. *Journal of Vertebrate Paleontology*, **32**, 1350–1357.

NESBITT, S. J., STOCKER, M. R., PARKER, W. G., WOOD, T. A., SIDOR, C. A. and ANGIELCZYK, K. D. 2017. The braincase and endocast of *Parringtonia gracilis*, a Middle Triassic suchian (Archosaur: Pseudosuchia). *Journal of Vertebrate Paleontology*, ***37***, 122-141.

PALCI, A., HUTCHINSON, M., CALDWELL, M. and LEE, M. 2017. The morphology of the inner ear of squamate reptiles and its bearing on the origin of snakes. *Royal Society Open Science*, **4**, 170685.

PAULINA-CARABAJAL, A. 2012. Neuroanatomy of titanosaurid dinosaurs from the Upper Cretaceous of Patagonia, with comments on endocranial variability within Sauropoda. *The Anatomical Record: Advances in Integrative Anatomy and Evolutionary Biology*, **295**, 2141-2156.

PAULINA-CARABAJAL, A. and SUCCAR, C. 2014. The endocranial morphology and inner ear of the abelisaurid theropod *Aucasaurus garridoi*. *Acta Palaeontologica Polonica*, **60**, 141-144.

PAULINA-CARABAJAL, A. and CURRIE, P. J. 2017. The braincase of the theropod dinosaur *Murusraptor*: Osteology, neuroanatomy and comments on the paleobiological implications of certain endocranial features. *Ameghiniana*, **54**, 617-640.

PAULINA-CARABAJAL, A. and FILIPPI, L. 2018. Neuroanatomy of the abelisaurid theropod *Viavenator*: The most complete reconstruction of a cranial endocast and inner ear for a South American representative of the clade. *Cretaceous Research*, **83**, 84-94.

PAULINA-CARABAJAL, A., STERLI, J., GEORGI, J., POROPAT, S. F. and KEAR, B. P. 2017. Comparative neuroanatomy of extinct horned turtles (Meiolaniidae) and extant terrestrial turtles (Testudinidae), with comments on the palaeobiological implications of selected endocranial features. *Zoological Journal of the Linnean Society*, **180**, 930-950.

PAULINA-CARABAJAL, A., LEE, Y. N. and JACOBS, L. L. 2016. Endocranial morphology of the primitive nodosaurid dinosaur *Pawpawsaurus campbelli* from the Early Cretaceous of North America. *PloS one*, **11**, e0150845.

PIERCE, S. E., WILLIAMS, M. and BENSON, R. B. J. 2017. Virtual reconstruction of the endocranial anatomy of the early Jurassic marine crocodylomorph *Pelagosaurus typus* (Thalattosuchia). *PeerJ*, **5**, e3225.

ROGERS, S. W. 1998. Exploring dinosaur neuropaleobiology: computed tomography scanning and analysis of an *Allosaurus fragilis* endocast. *Neuron*, **21**, 673-679.

SAMPSON, S. D. and WITMER, L. M. 2007. Craniofacial anatomy of *Majungasaurus crenatissimus* (Theropoda: Abelisauridae) from the late Cretaceous of Madagascar. *Journal of Vertebrate Paleontology*, **27**, 32–102.

SERENO, P. C., WILSON, J. A., WITMER, L. M., WHITLOCK, J. A., MAGA, A., IDE, O. and ROWE, T. A. 2007. Structural extremes in a Cretaceous dinosaur. *PLoS ONE*, **2**, e1230.

SOBRAL, G., SOOKIAS, R. B., BHULLAR, B. A. S., SMITH, R., BUTLER, R. J. and MÜLLER, J. 2016. New information on the braincase and inner ear of Euparkeria capensis Broom: implications for diapsid and archosaur evolution. *Royal Society Open Science*, **3**, 160072.

TROTTEYN, M. J. and PAULINA-CARABAJAL, A. 2016. Braincase and neuroanatomy of *Pseudochampsa ischigualastensis* and *Tropidosuchus romeri* (Archosauriformes, Proterochampsia). *Ameghiniana*, **53**, 527–542.

WALSH, S. A., BARRETT, P. M., MILNER, A. C., MANLEY, G. and WITMER, L. M. 2009. Inner ear anatomy is a proxy for deducing auditory capability and behaviour in reptiles and birds. *Proceedings of the Royal Society of London B: Biological Sciences*, **276**, 1355–1360.

WITMER, L. M. 2004. Inside the oldest bird brain. *Nature*, **430**, 619-20.

WITMER, L. M. and RIDGELY, R. C. 2009. New insights into the brain, braincase, and ear region of tyrannosaurs (Dinosauria, Theropoda), with implications for sensory organization and behavior. *The Anatomical Record,* **292**, 1266–1296.

WITMER, L. M., CHATTERJEE, S., FRANZOSA, J. and ROWE, T. 2003. Neuroanatomy of flying reptiles and implications for flight, posture and behaviour. *Nature*, **425**, 950–953.

WITMER, L. M., RIDGELY, R. C., DUFEAU, D. L. and SEMONES, M. C. 2008. Using CT to peer into the past: 3D visualization of the brain and ear regions of birds, crocodiles, and nonavian dinosaurs. 67–87. In ENDO, H. and FREY, R. (eds). Anatomical imaging: towards a new morphology. Springer, 110 pp.

YI, H. and NORELL, M. A. 2015. The burrowing origin of modern snakes. *Science Advances*, **1**, e1500743.