Electronic supplementary material

The youngest South American rhynchocephalian, a survivor of the K/Pg extinction

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ADDITIONAL DATA ON THE GEOLOGICAL FRAMEWORK

The type material of *Kawasphenodon peligrensis* comes from the 'Banco Negro Inferior' (BNI) of the Salamanca Formation outcropping at the coastal locality of Punta Peligro, which is about 27 km North of Comodoro Rivadavia in the Chubut province, Argentina (Suppl-fig. 1). The marine or nearshore sediments of the Salamanca Formation are well exposed within the slopes of the San Jorge Basin (Feruglio, 1949; Andreis et al., 1975; Legarreta and Uliana, 1994). These epeiric deposits are the result of the widespread marine transgression known as 'Salamancan Sea' that extensively flooded Patagonia during Late Cretaceous–Early Palaeocene times (Andreis et al., 1975). The BNI is part of the uppermost levels (Hansen Member) of the Salamanca Formation (Andreis et al., 1975; Legarreta y Uliana, 1994), with a thickness ranging from 1 to 8 meters (Gelfo et al., 2007). It consists of a package of dark sediments, comprising massive black clays with conchoidal fracture and some irregular conglomerates, with a whitish level of tuffaceous concretions on its lower part (Andreis et al., 1975). Most of the fossil vertebrates at Punta Peligro (Gelfo et al., 2007) were collected in this horizon.

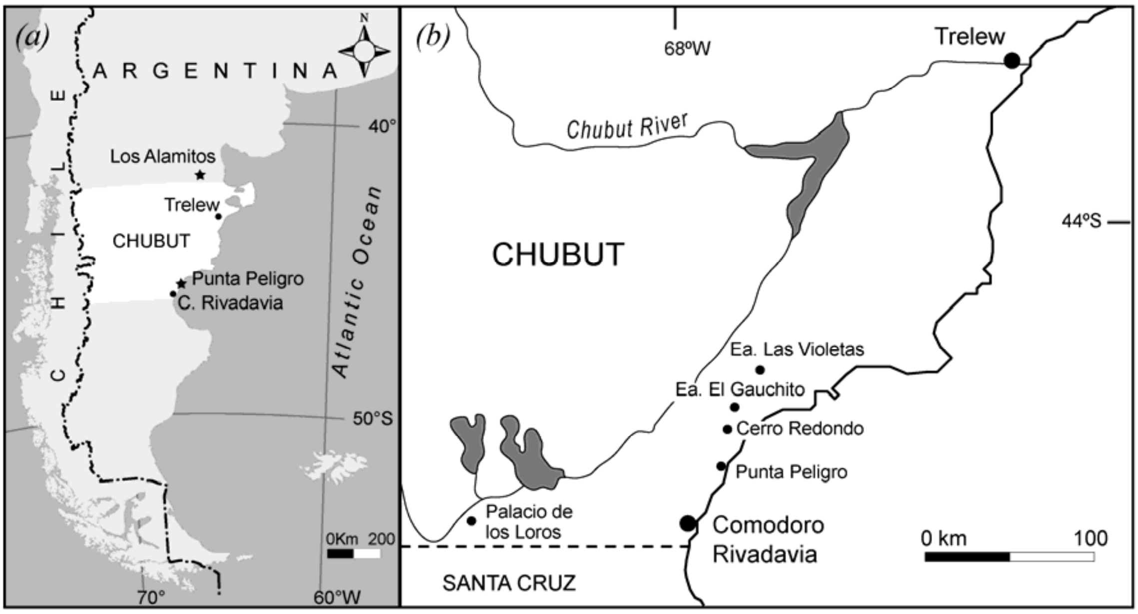
Punta Peligro has yielded one of the earliest known Palaeocene vertebrate faunas in South America (Bonaparte et al. 1993; Muizon 1998; Gelfo et al., 2009), the mammals were used to define the Peligran South American Land Mammal Age (SALMA; Bonaparte et al., 1993). To date the fauna includes, besides the newly described rhynchocephalian (this paper), relatively abundant remains of brackish environment including lamiid sharks, rays, abundant chelid turtles, and caimans (Bonaparte et al., 1993; de la Fuente and Bona, 2002; Páez Arango, 2008). Additionally, vertebrates that may be allochthonous have also been discovered at Punta Peligro, including calyptocephalellid frogs (some specimens reaching giant size), an undescribed sebecid crocodyliform, and a mixture of non-tribosphenic (dryolestoids, gondwanatheres) and tribosphenic (monotremes, therians) mammals (Pascual et al. 1992; Bonaparte et al., 1993; Pascual, 1996, 1998; Gelfo and Pascual 2001; Páez Arango, 2008).

The BNI has been interpreted as deposited in a brackish environment, such as a lagoon, formed during the withdrawal of the “Salamancan Sea” (Andreis et al., 1975). Palaeosoil structures have been indentified from this level and were considered evidence of aerial environments that developed under wet conditions (Andreis et al., 1975). These more continental conditions, however, could have been ephemeral, since marine deposits (rich in glauconite) overlay the BNI (Pascual and Ortiz Jaureguizar, 1991; Gelfo et al., 2007).

The age of BNI has been regarded as early Palaeocene (Bonaparte et al., 1993; Muizon, 1998), though both a precise geochronological date and the relative calibration of the Peligran SALMA (particularly with respect to the Tiupampan SALMA) have long been controversial (e.g., Marshall et al. 1981; Bonaparte et al. 1993; Somoza et al. 1995; Muizon 1998; Gelfo et al., 2009). An accurate calibration of the BNI has been attempted through radiometric dating of levels below or above the BNI, palaeomagnetic data, and their content of mammals. Radiometric dating with ^{40}K–^{40}Ar of levels of the Salamanca Formation below the BNI yielded ages of 64 ± 0.8, 62.8 ± 0.8, and 62.5 ± 5 Ma (Marshall et al. 1981; Marshall, 1982). The only radiometric date available from levels above the BNI is from a ^{40}Ar–^{39}Ar analysis that dated a tuff horizon located 40 m above the BNI at Palacio de los Loros locality (Suppl-fig. 1), about 100 km West of Punta Peligro, as 57.80 ± 6.00 Ma (Iglesias et al., 2007). Based on paleomagnetic data, the BNI was correlated with Chron 26r (between 59.2 and 62.2 Ma; Gradstein et al., 2012) at Punta Peligro and the area of Cerro Redondo (Marshall et al. 1981; Suppl-fig. 1), but with Chron 27n (between 62.2 and 62.5 Ma; Gradstein et al., 2012) at the El

Gauchito and Las Violetas farms (Suppl-fig. 1), farther North of Punta Peligro (Somoza et al. 1995). This regional asynchrony has been interpreted as related to the retreat of the 'Salamancan Sea' (Somoza et al. 1995), though other authors attribute this putative diachronism to methodological errors (Bonaparte et al., 1993).

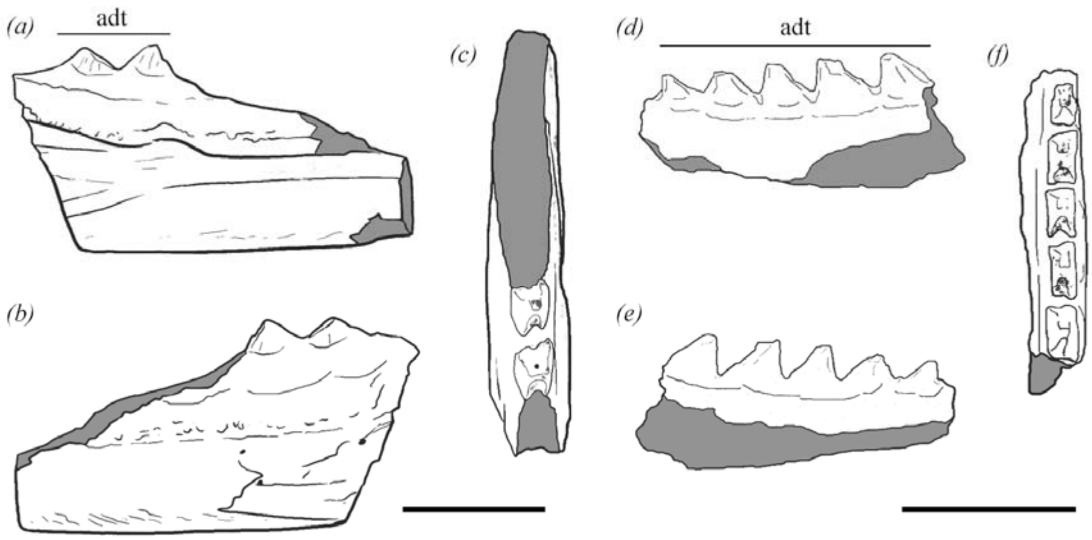
The relative age of the BNI based on paleontological data has also been debated, but always considered to be restricted to the Danian–Selandian interval. This way, the fauna from BNI at Punta Peligro (Peligran SALMA sensu Bonaparte et al., 1993) has alternatively been regarded as contemporary of the Tiupampan SALMA (Pascual and Ortiz Jaureguizar, 1990), between the older Tiupampan SALMA and the younger Itaboraian SALMA (Bonaparte et al., 1993; Gelfo et al., 2007, 2009), or even older than the Tiupampan SALMA (Marshall et al., 1997).



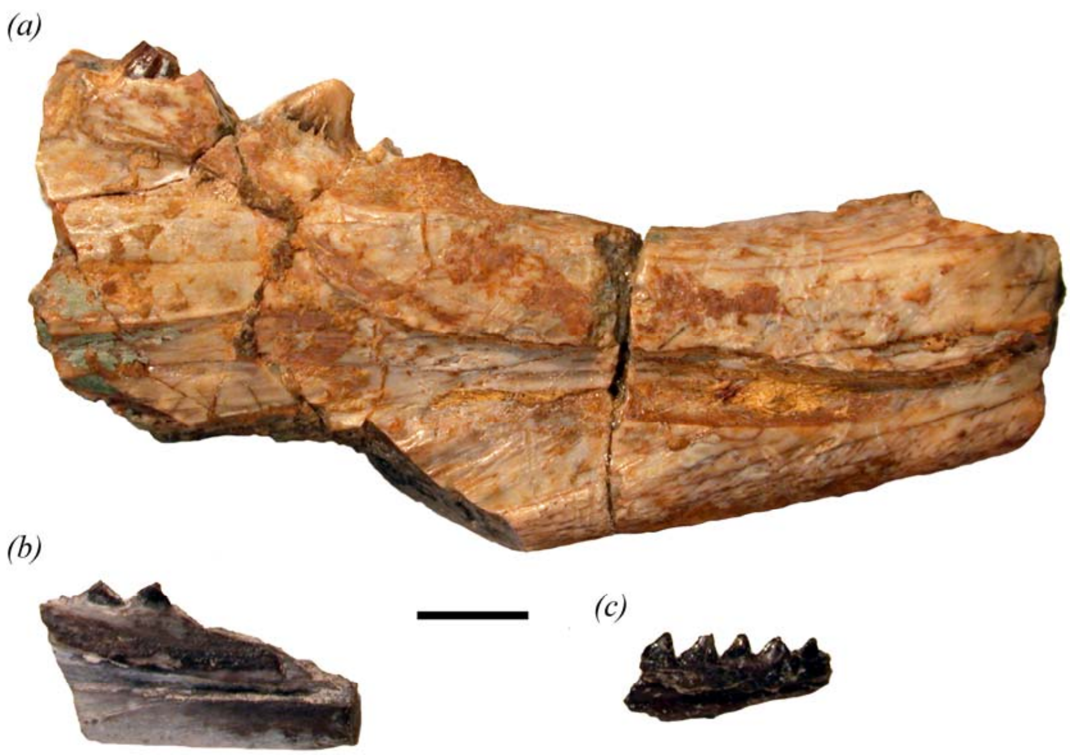
Suppl-fig. 1: *(a)* Map of Patagonia, Argentina, showing the localities of Punta Peligro and Los Alamitos. *(b)* Map of south-eastern Chubut province showing the location of different BNI localities named in the text.

ADDITIONAL DATA ON *KAWASPHENODON PELIGRENSIS* SP. NOV.

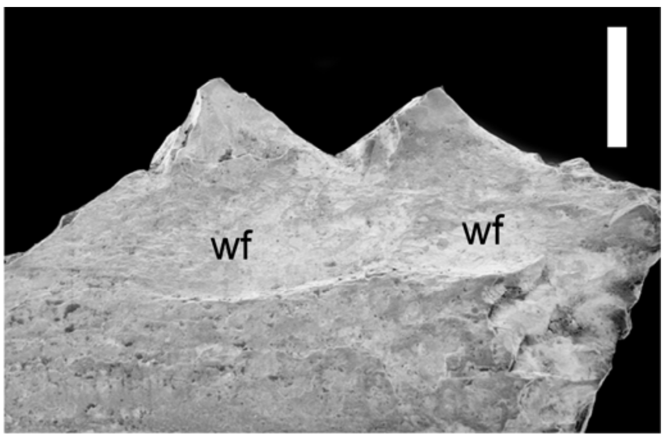
Additional figures



Suppl-fig. 2: *Kawasphenodon peligrensis* sp. nov. (*a*–*c*) Drawings of Holotype MPEF PV 1989. Left lower jaw in lingual (*a*), labial (*b*) and occlusal (*c*) views. (*d*–*f*) Drawings of Paratype MPEF PV 1990. Right lower jaw in lingual (*d*), labial (*e*) and occlusal (*f*) views. Abbreviations: adt, additional teeth. Scale bars: 5 mm.



Suppl-fig. 3: *(a) Kawasphenodon expectatus*, holotype MACN Pv RN1098 in lingual view. *(b) Kawasphenodon peligrensis* sp. nov., holotype MPEF PV 1989 in lingual view. *(c) Kawasphenodon peligrensis* sp. nov., paratype MPEF PV 1990 in labial view. All specimens are set to the same scale for size comparison. Scale bar: 5 mm.



Suppl-fig. 4: Scanning electron micrograph of *Kawasphenodon peligrensis* sp. nov., holotype MPEF PV 1989 showing wear facets (wf) on the secondary bone in labial view. Scale bar: 1 mm.

Selected measurements

Suppl-table 1: Selected measurements of the holotype and paratype of *Kawasphenodon peligrensis* sp. nov. in comparison to those of the holotype of *K. expectatus*.

select measurements (in mm)*	*K. peligrensis* MPEF PV 1989	*K. peligrensis* MPEF PV 1990	*K. expectatus* MACN Pv RN1098
Maximum width of most posterior well-preserved tooth	1.4	1.1	4.2
Maximum length of most posterior well-preserved tooth	2.3	1.8	5.5
Maximum height of most posterior well-preserved tooth	1.4	1.3	4.0
Maximum height of dentary anterior to coronoid process	6.4	-	23.0**
Height of dentary at anterior boundary of angular facet	6.1	-	13.6
Height of dentary ventral to Meckelian groove at anterior boundary of angular facet	2.2	-	4.3
Height of Meckelian groove at anterior boundary of angular facet	1.0	-	3.5
Maximum length of the preserved portion of bone	14.9	9.5	47.1

*The measurements were taken digitally in Adobe Photoshop CS.
** estimated

Body size

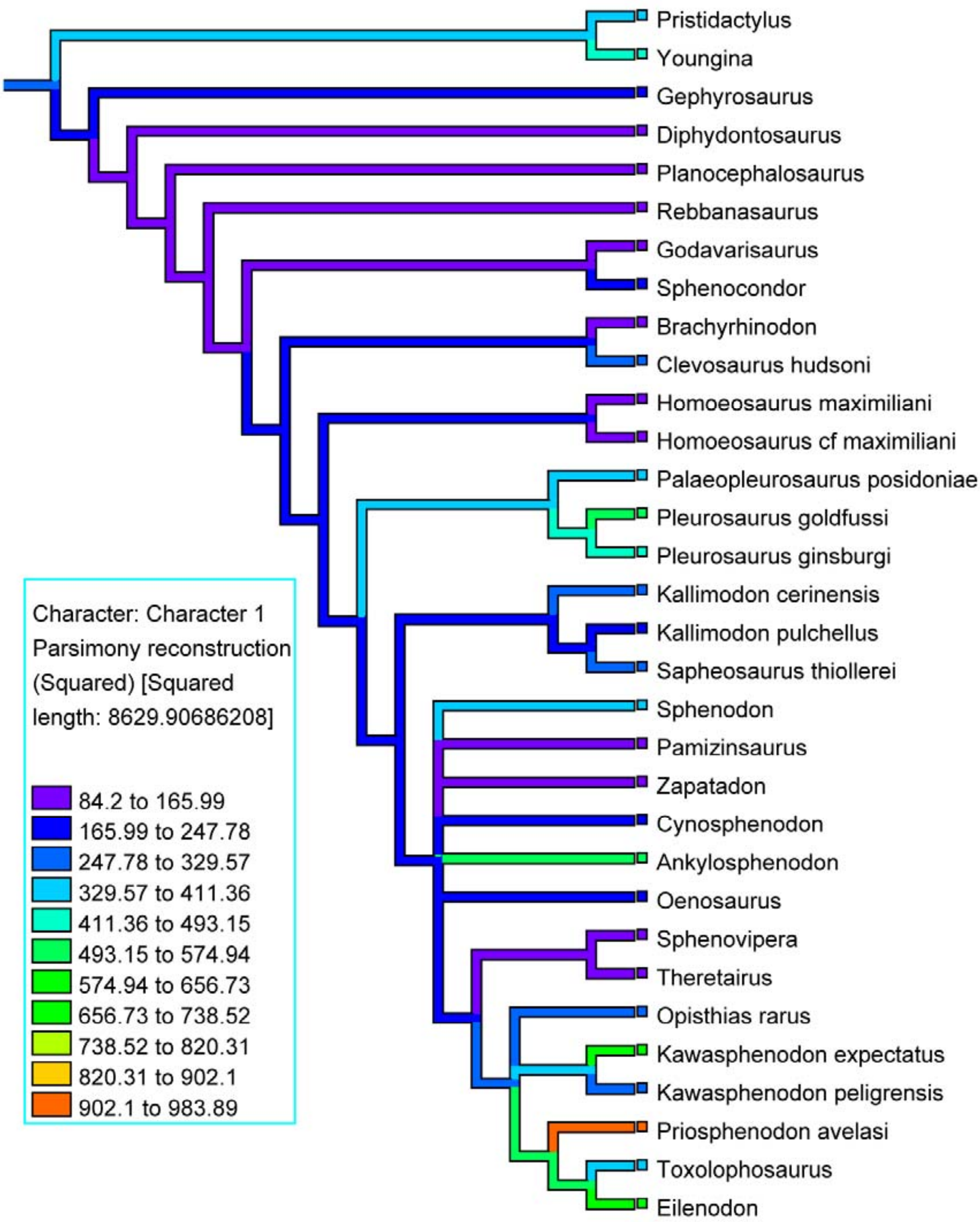
In order to estimate the size of fossil taxa we used part of the dataset of Wiens et al. (2006), of which we eliminated those squamate taxa that are limbless or have reduced limbs. Head length was regressed on snout-vent length (SVL, a proxy of total size) using a log-log reduced major axis (RMA) regression in the statistical package PAST (Hammer et al., 2001). Then, with the slope (0.939) and intercept (0.91192) of the regression we used the skull length of fossils (a proxy of the head length; Suppl-table 2) to estimate their SVL. In the case of those fossils in which the entire skull is not preserved (e.g., *Kawasphenodon peligrensis*), we either relied on published restorations or estimated the skull length using a related taxon with known skull length as a template. Particularly, in the case of *Kawasphenodon peligrensis* we digitally matched both the holotype and paratype with those parts of the dentaries of *Opisthias rarus* and *Sphenodon punctatus* that minimizes the differences between specimens and then estimated the jaw and skull lengths. These estimations were used to represent the size of fossil taxa by black silhouettes in figure 2.

Additionally, to test the hypothesis that *K. peligrensis* constitutes a case of dwarfism within Opisthodontia, the estimated body size was optimized in the topology recovered by the phylogenetic analysis as a continuous character (Suppl-fig. 5) using squared parsimony in Mesquite (Maddison and Maddison, 2011).

Suppl-table 2: Skull length (SkL) of fossils and estimated SVL, using the function log SVL= log SkL * 0.939 + 0.91192.

measurements (in mm)*	SkL	SVL**
K. peligrensis **MPEF PV 1989**	38**	248
K. peligrensis **MPEF PV 1990**	37**	242
K. expectatus **MACN Pv RN1098**	110**	674
Ankylosphenodon	83	517
Brachyrhinodon	23	155
Clevosaurus hudsoni	39	254
Cynosphenodon	29	192
Diphydontosaurus	15	103
Eilenodon	109	668
Gephyrosaurus	30	199
Godavarisaurus	15**	103
Homoeosaurus maximilliani	24	161
Homoeosaurus **cf.** ***maximilliani***	24	161
Kallimodon pulchellus	30	199
Kallimodon cerinensis	38	248
Opisthias rarus	42	272
Palaeopleurosaurus	57	363
Pamizinsaurus	16	110
Planocephalosaurus	20	136
Pleurosaurus goldfussi	82	511
Pleurosaurus ginsburgi	76	476
Priosphenodon avelasi	150	902
Rebbanasaurus	15**	103
Sapheosaurus	41	266
Sphenocondor	28**	186
Sphenovipera	21**	142
Theretairus	20**	136
Toxolophosaurus	60	381
Youngina	75	470
Zapatadon	12	84

*The measurements were taken digitally in Adobe Photoshop CS.
** estimated



Suppl-fig. 5: Mapping of body size estimates onto the Rhynchocephalian phylogeny.

PHYLOGENETIC ANALYSIS

Taxon and character sampling

In order to assess the evolutionary relationships of *Kawasphenodon peligrensis* sp. nov. we added it to a modified version of a recently published data matrix of rhynchocephalians (Apesteguía et al., 2012). The modifications involved both the addition of taxa, characters, and character states, but also included changes in the scoring of terminals or the character statements.

Regarding the taxon sampling, we added to the dataset of Apesteguía et al. (2012) species of *Pleurosaurus* (*P. goldfussi* and *P. ginsburgi*) and the recently described *Oenosaurus muehlheimensis* (Rauhut et al., 2012). Additionally, we aimed to be more explicit in the way some terminals were scored and therefore we used species, or even specimens, as terminals; this was particularly significant for the scoring of *Homeosaurus*, *Kallimodon*, and *Opisthias*. In total, including *K. peligrensis*, six new terminals were added to the data matrix of Apesteguía et al. (2012).

With respect to the characters, 68 of the 74 used in the analysis were previously considered by Apesteguía et al. (2012). Four characters of the latter, mainly regarding skull and body proportions, were removed for non independence issues. In addition, six new characters concerning shape of the humerus (ch. 62, 63), tooth morphology (ch. 71, 72), and shape of maxilla (ch. 73, 74) were incorporated to the data matrix. Also, some character states were added in order to include observed variation within the taxon sample.

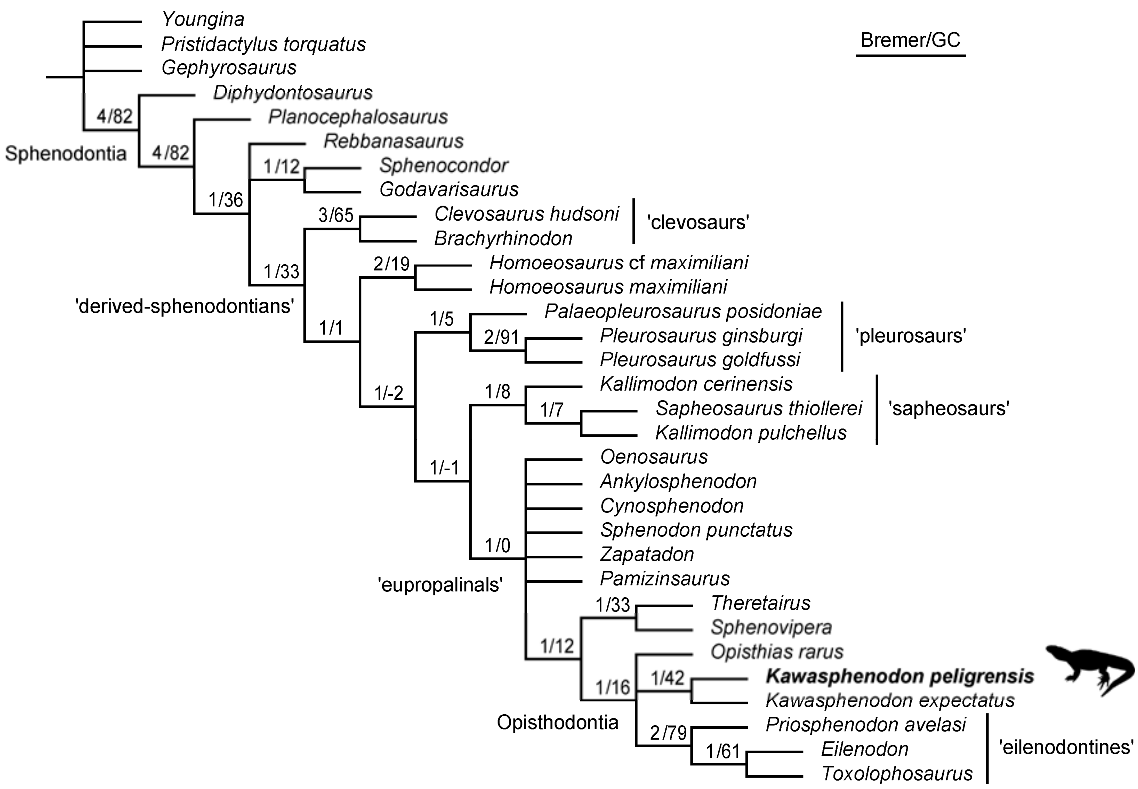
Heuristic tree search and results

We performed a heuristic search in TNT v.1.1 (Goloboff et al., 2008) using Maximum Parsimony as optimality criterion and under equal weights. The tree search consisted of 500 replicates of Wagner trees with random addition sequence of taxa followed by Tree Bisection and Reconection (TBR) branch swapping, holding ten trees per replication, and collapsing branches of zero length after tree search following rule 1 of Coddington and Scharff (1994). Multistate characters were treated as unordered during the tree search. Most-parsimonious trees (MPTs) were rooted with the distantly related diapsid *Youngina*.

The analysis yielded 22 MPTs of 218 steps, in all of which *K. peligrensis* appears as sister-group of *K. expectatus* (Suppl-fig. 6). The strict consensus of these MPTs is relatively well resolved, with the exception of the node including all 'eupropalinals'. It is noteworthy that this node, as the three nodes immediately below it, has low support values. The uncertainties mainly involve the interrelationships between *Homeosaurus*, pleurosaurs, sapheosaurs, and some eupropalinal taxa within crown-sphenodontians. Despite this ambiguity, the results reflect previous phylogenetic hypothesis of rhynchocephalians (e.g., Reynoso, 1996, 2005; Apesteguía and Novas, 2003; Apesteguía et al., 2012). The main previously recognized groups were consistently recovered, including Sphenodontia (sensu Benton, 1985), 'derived sphenodontians' (sensu Apesteguía et al., 2012), and Opisthodontia (sensu Apesteguía and Novas, 2003), as well as clades of clevosaurs, pleurosaurs, sapheosaurs, and eilenodontines. Additionally, a clade of eupropalinal forms was recovered (previously recognized by Apesteguía and Carballido, in press), although it has low support (Suppl-fig. 6).

In agreement with previous hypotheses (Apesteguía and Rougier, 2007, Apesteguía et al., 2012), *Kawasphenodon* is related to opisthodontians, recovered in a polytomy with

Opisthias rarus and eilenodontines. Opisthodontians, including *Kawasphenodon*, share the presence of additionals that are square to transversely rectangular in cross section and moderately to tightly packed in the jaw, moving in a prooral fashion (see below for a list of synapomorphies for all the nodes).



Suppl-fig. 6: Strict consensus of 22 MPTs obtained in the phylogenetic analysis depicting the position of *Kawasphenodon peligrensis* sp. nov. Node support (Bremer/GC) is shown above branches.

Support measures

Node support was assessed by 1000 rounds of symmetric resampling and expressed as frequency difference (GC) values (Goloboff et al., 2003).and by calculating the Bremer index in TNT.

Character list

Description of 74 characters used in the phylogenetic analyses, 68 of which are the same used by Apesteguía et al. (2012), although some of them were modified (denoted with an asterisk). Four characters of the latter were removed because of non independence issues. Between brackets the original source of each character is indicated. Also, six new characters regarding shape of the humerus (ch. 62, 63), tooth morphology (ch. 71, 72), and shape of maxilla (ch. 73, 74) were added. Multistate characters were treated as unordered. Abbreviations: AGR12, Apesteguía et al. (2012); AN03, Apesteguía & Novas (2003); B85, Benton (1985); E88, Evans (1988); FB89, Fraser & Benton (1989); G88, Gauthier et al. (1988); R96, Reynoso (1996); R97, Reynoso (1997); RC98, Reynoso & Clark (1998); S94, Sues et al. (1994); W94, Wu (1994).

(1) Antorbital region, length relative to skull length: one-third or more (0); between one-fourth and one-third (1); one fourth or less (2). (S94, W94, R96, AN03)

(2) Orbit, length relative to skull length: one third or greater (0); less than one third (1). (RC98, AN03)

(3) Supratemporal fenestra, length relative to orbit length: less than 75% (0); 75% or greater (1). (S94, AN03)

(4) Supratemporal fenestra, length relative to skull length: one-fourth or less (0); more than one-fourth (1). (W94, R96, AN03)

(5) Lower temporal fenestra, length relative to skull length: one-fourth or less (0) ; more than one-fourth (1). (W94, R96, AN03)

(6) Maxilla, premaxillary process: elongate (0); reduced (1). (S94, W94, R96, AN03)

(7) Maxilla, participation in margin of external naris: entering into margin (0); excluded from margin by posterodorsal process of premaxilla (1). (S94, R97, AN03)

(8) Maxilla, shape of posterior end: tapering posteriorly or very narrow (0); dorsoventrally broad (1). (W94, R96, AN03)

(9) Lacrimal: present (0); absent (1). (S94, W94, R96, AN03)

(10) Jugal, shape of dorsal process: broad and short (0); narrow and elongate (1). (W94, R96, AN03)

(11) Prefrontal and postfrontal, profuse sculpture on bone surface: absent (0); present (1). (AN03)

(12) Prefrontal-jugal contact: absent (0); present (1). (S94, R97, AN03)

(13) Postorbital, marked dorsal ridge and deep ventrolateral concavity: absent (0); present (1). (AN03)

(14) Frontals, relation: separated (0); fused (1). (S94, W94, R96, AN03)

(15) Parietals, relation: separated (0); fused (1). (S94, W94, R96, AN03)

(16) Parietal, width between supratemporal passages relative to interorbital width: broader (0); narrower (1). (S94, W94, R96, AN03)

(17) Parietal crest: absent (0); present (1). (S94, W94, R96, AN03)

(18) Parietal, shape of posterior edge: greatly incurved inward (0); slightly incurved inward (1); convex (2). (W94, R96, AN03)

(19) Parietal foramen, position relative to anterior border of supratemporal fenestra: posterior (0); at the same level or anterior (1). (S94, W94, R96, AN03)

(20) Lower temporal bar, position: aligned with the maxillary tooth row (0); bowed away beyond the limit of the abductor chamber (1). (S94, W94, R96, AN03)

(21) Lower temporal bar, posteroventral process of jugal: absent (0); poorly- to moderately-developed, less than half the length of the lower temporal fenestra (1); well-developed, half the length of the lower temporal fenestra or more (2). (S94, W94, R96, AN03)

(22) Palatine, shape of posterior end: tapers posteriorly (0); widens posteriorly (1). (S94, W94, R96, AN03)

(23) Pterygoids, anterior contact between bones*: absent (0); small (1); broad (2). (R97, AN03)

(24) Pterygoids, posterior opening of the interpterygoid vacuity between posteromedial processes: widely open (0); moderately open, as wide as the vacuity (1); almost closed by the posteromedial processes (2). (R97, AN03)

(25) Pterygoid, central region between three rami: short (0); elongate (1). (S94, W94, R96, AN03)

(26) Pterygoid, participation in margin of suborbital fenestra: form part of the margin (0); excluded from margin (1). (S94, W94, R96, AN03)

(27) Quadrate-quadratojugal foramen, relative size: small (0); large (1). (RC98, AN03)

(28) Quadrate-quadratojugal foramen, location: between the quadrate and the quadratojugal (0); entirely within the quadrate (1). (RC98, AN03)

(29) Quadrate-quadratojugal emargination, shape: pronounced (0); reduced (1). (E88, S94, W94, RC98, AN03)

(30) Supratemporal, as a discrete bone: present (0); absent (1). (S94, R97, AN03)

(31) Inferred jaw motion: orthal (0); propalinal (1). (S94, W94, R96, AN03)

(32) Degree of propalinality, measured either as palatal tooth row extension or length in which palatines keep parallel to the maxillae: small palatal row, parallel line restricted to the anterior region (0); enlarged, palatines accompanying maxilla half

its own length (1); palatines accompanying maxilla by its complete length, ‘eupropalinality’ (2). (S94, W94, R96, AN03)

(33) Mandibular symphisis, mentonian process*: absent (0); reduced (1); well-developed and pointed (2); well-developed and rounded (3). (AN03)

(34) Mandibular symphysis, shape: almost circular, high/length relation near one (0); oval, high/length clearly greater than one (1). (B85, R96, AN03)

(35) Mandibular symphysis, angle between anterior margin and longitudinal axis of the mandible in lateral view: <120º, symphysis nearly vertical, typically devoid of ventral projections (0); ≥120º, symphysis anterodorsally projected (1). (AN03)

(36) Mandibular symphysis, symphysial spur: absent (0); well-developed, anterodorsally projected (1); moderately developed (2). (AN03)

(37) Mandibular foramen, relative size: small (0); large (1). (B85, R96, AN03)

(38) Glenoid cavity, shape: smooth surface, lacking an anteroposterior central ridge (0); elongate and asymmetrical surface, with a strong anteroposterior central ridge (1); symmetrical facet with a strong anteroposterior central ridge (2). (AN03)

(39) Coronoid process, height relative to that of the jaw at the level of the anterior end of the coronoid process: low, weak, less than half the jaw (0); high, equal or more than half the jaw height (1). (S94, W94, R96, AN03)

(40) Retroarticular process, shape: pronounced (0); reduced, caudally projected (1); reduced, dorsally curved (2). (S94, W94, R96, AN03)

(41) Dentary, posterior process, relative length: short, not reaching glenoid level (0); elongate, reaching glenoid level (1); elongate, reaching the end of glenoid level (2). (S94, R97, AN03)

(42) Marginal dental implantation, type: pleurodont (0); degree of posterior acrodonty (1); fully acrodont (2). (S94, W94, R96, AN03)

(43) Tooth replacement, type: alternate (0); addition at back of jaw (1). (B85, R96, AN03)

(44) Dentary regionalization with small juvenile teeth (hatchling) in the anterior region of maxilla and dentary: absent, only pleurodont teeth (0); present, with hatchling pleurodont teeth (1); present, with hatchling, successional and additional acrodont teeth (2); absent both in juveniles and adults, only additional acrodont teeth (3). (B85, R96, AN03)

(45) Dentary, posterior successionals, number in mature individuals: zero (0); one (1); two or more (2). (G88, R96, AN03)

(46) Marginal teeth, lateral wear facets on dentary and/or medial wear facets on maxilla: absent or smooth (0); present, conspicuous (1). (S94, W94, R96, AN03)

(47) Marginal teeth, shape of cross section of posterior teeth: nearly circular (0); squared (1); rectangular, wider than long (2). (FB89, R96, AN03)

(48) Premaxillary teeth, number in mature individuals: more than seven (0); seven to four (1); three or less (2). (S94, W94, R96, AN03)

(49) Premaxillary teeth, general organization in adults: present as discrete teeth (0); merged into a chissel-like structure (1). (S94, W94, R96, AN03)

(50) Maxillary teeth, posteromedial flanges on posterior teeth: absent or inconspicuous (0); present as small flanges on at least one tooth (1); present as extensive flanges on most teeth (2). (S94, W94, R96, AN03)

(51) Maxillary teeth, anterolateral flange on posterior teeth: absent (0); present (1). (AN03)

(52) Palatine teeth, number of tooth rows: two or more (0); a single row plus one isolated tooth (1); a single lateral row (2). (S94, W94, R96, AN03)

(53) Palatine teeth, flanges: completely absent (0); present at least on a few teeth (1). (FB89, R96, AN03)

(54) Palatine teeth, hypertrophied tooth on anterior region of the palatine bone (stabbing palatine): absent (0); present (1). (AN03)

(55) Pterygoid teeth, number of tooth rows*: three or more (0); two (1); one or none (2); radial crests (3). (S94, W94, R96, AN03)

(56) Mandibular teeth, anterolateral flanges: absent (0); present, at least in one tooth (1). (S94, W94, R96, AN03)

(57) Mandibular teeth, anteromedial flanges: absent (0); present (1). (AN03)

(58) Mandibular teeth, additionals, enamel ornamentation in adults*: absent (0); present, with numerous fine striae (1); present, with a combination of a few striae and wide grooves (2). (AN03)

(59) Second sacral vertebra, posterior process: absent (0); present, small (1); present, prominent (2). (G88, R96, AN03)

(60) Ischium, process on posterior border: absent (0); present as small tubercle (1); present as prominent process (2). (E88, FB89, R96, AN03)

(61) Humerus, length relative to length of presacral column*: <0.12 (0); between 0.12 and 0.21 (1); > 0.21. (FB89, R96, AN03)

(62) Humerus, shape, relation between minimum width of the diaphysis (DW) and maximum length of bone (HL): $DW/HL \leq 0.11$ (0); $DW/HL > 0.11$ (1).

(63) Humerus, shape, relation between minimum width of the diaphysis (DW) and maximum width of distal epiphysis (EW): $DW/EW < 0.28$ (0); DW/EW between 0.28−0.35 (1), $DW/EW > 0.35$ (2).

(64) Dentary, proportions (pre-coronoid length/ maximum pre-coronoid height ratio, L/H): gracile, long and low, L/H < 0.18 (0); average, L/H between 0.18−0.28 (1), robust, short and high, L/H > 0.28 (2). (AGR12)

(65) Dentary, successional teeth, maximum concurrent number during ontogeny: six or more (0); three to five (1); two or less (2). (AGR12)

(66) Dentary, anterior successional teeth (not ‘caniniform’), number in the adult: two or more clearly discrete teeth (0); one or two poorly distinct (1); none or indistinct (2). (AGR12)

(67) Dentary, successional teeth, striation: present (0); absent (1). (AGR12)

(68) Dentary, posterior successional teeth, lingual groove: absent (0); present (1). (AGR12)

(69) Dentary, hatchling teeth, striation: absent (0); present (1). (AGR12)

(70) Dentary, successional ‘caniniform’ teeth, shape of basal cross section: nearly circular (0); clearly oval, labio-lingually compressed (1). (AGR12)

(71) Mandibular teeth, additionals, grooves or fossae on labial or lingual sides: absent (0); present (1).

(72) Mandibular teeth, additionals, posterior groove: absent (0); wide and poorly-defined (1); relatively deep and well-defined (2).

(73) Maxilla, facial process, shape of anterior margin relative to main axis of maxilla: low slope, straight or concave (0); high slope, in straight angle (1); high slope, continuous and concave (2); high slope, continuous and convex (3).

(74) Maxilla, facial process, maximum high (FH) with respect to length of maxilla posterior to this point (MPL): FH/MPL < 0.45 (0); FH/MPL between 0.45−0.7 (1); FH/MPL > 0.7 (2).

Data matrix

Data matrix of 74 characters scored for 32 taxa used in the phylogenetic analysis. Symbols: ?, missing data or not applicable; A=0/1; B=0/2; C=1/2; D=2/3

Taxa	5 10 15 20 25 30 35 40
Ankylosphenodon	???1?????1????????????????????1?111?1?11
Brachyrhinodon	211111011100?000000120120?????0011101?10
Clevosaurus hudsoni	2111111111010001000120210100000011101110
Cynosphenodon	??????????????????????????????1?2112??1?
Diphydontosaurus	1000000010000100000120100000010100001000
Eilenodon	??????????1???????????????????1231111202
Gephyrosaurus	0000000000000110000120000000010100?00000
Godavarisaurus	??????1????????????????????????0110B????
Homoeosaurus cf maximiliani	11AA??????0??00?0?11?02??1?????A1???1?11
Homoeosaurus maximiliani	1A0000011000?0000C11??2001???10111101?11
Kallimodon cerinensis	???????????????????1??2010?????A110?1?A?
Kallimodon pulchellus	01110?011?00?0011211112001???10A11021?10
Kawasphenodon expectatus	??????????????????????????????1?????????
Kawasphenodon peligrensis	??????????????????????????????1?????????
Oenosaurus	20???0?1??0?10111????02201????11D?121111
Opisthias rarus	????????????????????????????????3111??A?
Palaeopleurosaurus	01110000100010111200202110110100111?1?1A
Pamizinsaurus	??????1???0????????????211??0?0?C11?1?11
Planocephalosaurus	0000000010000110010120200001010111000010
Pleurosaurus ginsburgi	0110?0001?00?001????0?????????0?0110????
Pleurosaurus goldfussi	0110?0001100?0011210002C101001020110??00
Priosphenodon avelasi	0110011111111001111101220100011231111202
Pristidactylus	1111100001100110001?0001000?000?00?00000
Rebbanasaurus	???????01??0??????????????????0?3102????
Sapheosaurus thiollerei	111100?1?0???0011211211001????0A11021?10
Sphenocondor	????????????????????????????????1?1?1?1?
Sphenodon punctatus	1111100111001001111121221110111211121111
Sphenovipera	??????????????????????????????1?21021???
Theretairus	??????????????????????????????1?210?????
Toxolophosaurus	??????????????????????????????1?31111?0?
Youngina	00000000000000000000200000000?0000?0?000
Zapatadon	10?01??01??1??1?1?1?102210101A1?1112??1?

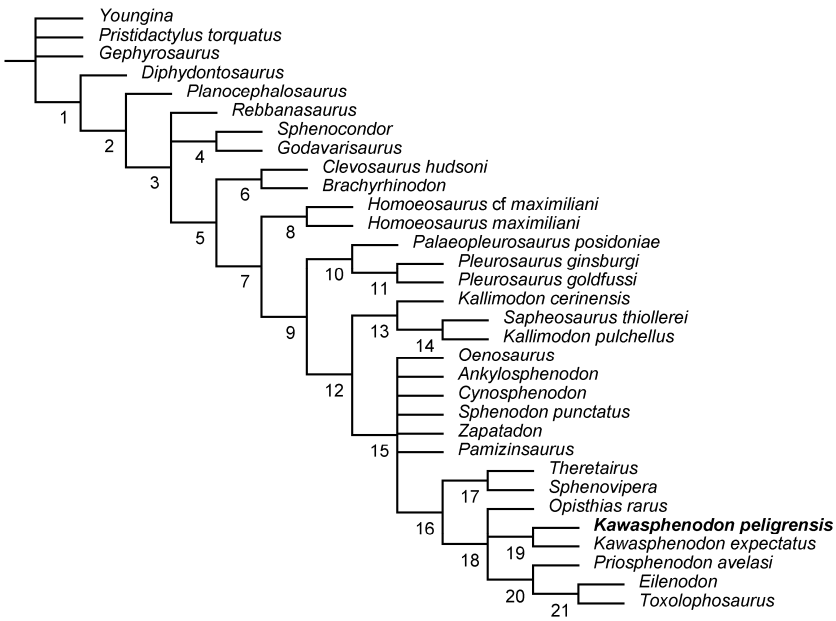
Data matrix (continued)

Taxa	45 50 55 60 65 70 74
Ankylosphenodon	121?01????0????0?0221??121????0???
Brachyrhinodon	121201121101001?????1??1????????21
Clevosaurus hudsoni	1212011212010011012 11??112??0?0021
Cynosphenodon	?2121112110????100?????11210010011
Diphydontosaurus	11112001000000000121???000001?0000
Eilenodon	22130122?21210?112?????222????0122
Gephyrosaurus	10002000000000000?102??00010??0001
Godavarisaurus	?212200C01021??100?????A10010100??
Homoeosaurus cf maximiliani	121D01A??20C??2?????2??1??????????
Homoeosaurus maximiliani	121201A21202??2111222??1??????000?
Kallimodon cerinensis	1212??A21202002000221??122????00??
Kallimodon pulchellus	121201121202??2001221??122????00??
Kawasphenodon expectatus	?212?10?????1??112?????C??????02??
Kawasphenodon peligrensis	?21D?10????????112????????????02??
Oenosaurus	12??0?A????2?02000?????2?2????00?1
Opisthias rarus	?212010??20????112?????122????10??
Palaeopleurosaurus	121201121102002101210??022????0001
Pamizinsaurus	?2120?A2?102???101?????12???1?????
Planocephalosaurus	1212?0A20100001101211??1C00?1?0010
Pleurosaurus ginsburgi	?21D0012000??0?110120??022????0000
Pleurosaurus goldfussi	121200120002102110?20??022????0000
Priosphenodon avelasi	2213012212121031122C2??222????0032
Pristidactylus	00002000000???200?111??00010??0001
Rebbanasaurus	?21220020100 1??101?????A11000100??
Sapheosaurus thiollerei	A???01?21?0???2???221??122????????
Sphenocondor	1212200????????0?0?????0C?010100??
Sphenodon punctatus	121211A21102112100012??C2210000011
Sphenovipera	1212211????????112?????1C211??10??
Theretairus	?21221?????????1???????12?10??00??
Toxolophosaurus	?213012????????112?????222????01??
Youngina	00002000000000000?10???00010??0000
Zapatadon	?2120?A??102??2????????12????????0

Synapomorphies

Suppl-table 3: List of common synapomorphies for all MPTs obtained in the phylogenetic analysis. Symbols: ch. = character; > = direction of change. See Suppl-fig. 7 below for node numbers on the strict consensus.

Node number	Synapomorphies
1	ch. 9: 0>1 ch. 43: 0>1 ch. 59: 1>2 ch. 67: 1>0
2	ch. 33: 0>1 ch. 34: 0>1 ch. 39: 0>1 ch. 50: 0>1 ch. 55: 0>1 ch. 56: 0>1 ch. 65: 0>1
3	ch. 32: 1>0 ch. 69: 1>0
4	ch. 58: 1>0 ch. 68: 0>1
5	ch. 8: 0>1 ch. 35: 0>1 ch. 45: 2>0 ch. 46: 0>1 ch. 47: 0>1 ch. 49: 0>1 ch. 66: 0>2
6	ch. 5: 0>1 ch. 6: 0>1 ch. 10: 0>1 ch. 73: 0>2
7	ch. 18: 0>2 ch. 19: 0>1 ch. 55: 1>2 ch. 60: 1>2
8	ch. 40: 0>1 ch. 50: 1>2
9	ch. 16: 0>1 ch. 17: 0>1 ch. 25: 0>1
10	ch. 8: 1>0 ch. 20: 1>0 ch. 24: 0>1 ch. 26: 1>0 ch. 61: 12>0 ch. 65: 1>0
11	ch. 21: 2>0 ch. 33: 1>0 ch. 46: 1>0 ch. 49: 1>0 ch. 50: 1>0 ch. 57: 0>1 ch. 74: 1>0
12	ch. 36: 0>2
13	ch. 35: 1>0 ch. 50: 1>2 ch. 56: 1>0
14	ch. 25: 1>0
15	ch. 10: 0>1 ch. 18: 2>1 ch. 24: 0>2 ch. 31: 0>1 ch. 32: 0>2 ch. 40: 0>1
16	ch. 57: 0>1 ch. 58: 0>2
17	ch. 35: 1>0 ch. 45: 0>2
18	ch. 36: 2>1 ch. 47: 1>0
19	ch. 72: 0>2
20	ch. 44: 2>3 ch. 47: 0>2 ch. 51: 0>1 ch. 64: 1>2
21	ch. 72: 0>1



Suppl-fig. 7: Strict consensus of 22 MPTs obtained in the phylogenetic analysis showing node numbers.

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