
Supplementary information

**Multiple paths to morphological
diversification during the origin of
amniotes**

In the format provided by the
authors and unedited

Supplementary Dataset 1

Character List

Because the matrices forming the basis of this character list are designed to examine relationships of specific clades, many include characters with specific morphological descriptions that are not relevant to the taxa in other clades. The most obvious example is the use of incisors/incisiform teeth and molars/molariform teeth in therapsid/diadectid character lists, which are not relevant to taxa without mammal-like differentiation. Characters referring to canine, precanine and postcanine teeth are not relevant to taxa without a caniniform tooth/region. In the case of characters referring to the canine and caniniform teeth the obvious solution is to score taxa not possessing such teeth as inapplicable. But for precanine/incisor teeth and molar/postcanine teeth, one must attempt to avoid issues of redundancy and character non-independence with characters referring to premaxillary/maxillary teeth or lateral dentition in general. One cannot, for example, have characters referring to the number/morphology of incisors, score taxa without incisiform teeth as inapplicable, but then include a character referring to the number of premaxillary teeth so that variation in taxa without heterodonty may be accounted for.

In compiling this character list, the following practices are observed when choosing and rewording characters. These practices have been formulated with eco-functionality in mind, rather than homology (as would be used when formulating characters used in phylogenetic analysis).

- The upper teeth will be defined by the bone in which they are implanted (premaxillary and maxillary). With dentary teeth, this becomes more problematic, as incisors, canines and molars are all found within a single bone, so different practices are applied (see below).
- The maxillary teeth are divided between caniniform and non-caniniform; if a caniniform region/tooth is not present, all characters relating to caniniforms are scored as inapplicable, and all maxillary teeth are treated as non-caniniforms
- Canines/caniniforms are defined as being a single tooth or region with teeth noticeably longer than those before or after them in the maxilla. This definition does not include precanine maxillary teeth, which in some descriptions of therapsids in the 1910s-1940s were referred to as canines/micro-canines.
- Characters referring to molars/molariform teeth have been reworded to refer to non-caniniform maxillary teeth. In taxa where there is no canine or caniniform region this will account for all maxillary teeth. In cases where there is a canine or caniniform region this will account only for postcanines
- Some characters specify postcanine maxillary teeth. No characters in the source matrix referred to the precanines except one referring to their number. Since characters relating to the total number of maxillary teeth and the number of postcanine maxillary teeth will by proxy allow variation in the number of precanine maxillary teeth to be accounted for, this character was ignored.
- Characters referring to upper incisors have been reworded and if necessary rescored to relate to teeth implanted in the premaxilla.

- Characters relating to overall tooth morphology are no longer included. Variation in tooth morphology in taxa with no heterodonty or heterodonty only in that they have canines will be accounted for by characters referring to the morphology of the non-canine maxillary teeth and the premaxillary teeth being scored for the same character state.
- Characters relating to dentary incisors/molars are reworded and rescored as precanine and postcanine teeth and are scored as inapplicable in taxa without a dentary canine. If a character refers to both upper and lower incisors or anterior dentary teeth, the dentary teeth included in the scoring of the character are those that cover a portion of the dentary equivalent to the fraction of length of the tooth row covered by premaxillary teeth. For characters referring to both upper and lower molars the same logic is applied; the dentary teeth included in the scoring of the character are those that cover a portion of the dentary equivalent to the fraction of length of the tooth row covered by non-canine maxillary teeth
- Palatal tooth characters are arranged by tooth field. This has the biggest effect when considering the teeth on the anterior ramus of the pterygoid. Sometimes this tooth field will extend laterally onto the ectopterygoid and palatine, or even anteriorly onto the vomer, but this still counts as the anterior ramus tooth field and so should not be considered as representing the presence of an ectopterygoid/palatine/vomerine tooth field. Tooth fields in close proximity or which seem confluent with each other may be considered separate tooth fields if there is a noticeable and abrupt shift in size/organisation coinciding with the transition to a new bone. E.g. palatal dentition of *Seymouria sanjuanensis* – the tooth field of the anterior ramus of the pterygoid forms numerous denticle rows which extend anteriorly onto the posteriormost portion of the vomer. These posterior vomerine denticles are of similar size to the pterygoid denticles and clearly form rows that are extensions of those on the pterygoid. Therefore, these denticles are still considered part of the tooth field on the anterior ramus of the pterygoid (a character is included indicating whether the pterygoid tooth field extends onto the vomer). However, there are also denticles on the anteriormost vomer. These are separated from those more posteriorly by a noticeable gap, and also are not organised in rows in the same way that the posterior denticles are. Therefore, these represent a separate, vomerine tooth field. Also present are vomerine fangs, which are again treated separately.
- For purposes of coding for the presence or absence of teeth on the coronoids, the pattern of loss of the individual coronoids is judged to be from anterior to posterior i.e. where two coronoids are present, they are the posterior and middle coronoid; where one is present it is the posterior coronoid.

- 1) Tooth implantation: subthecodont (=protothecodont) (0); ankylothecodont (1); pleurodont (2); acrodont (3); thecodont (4)
 - [1] character 299
- 2) Tooth pedicely: absent (0); present (1).
 - [2], character 80

- 3) Number of lateral premaxillary teeth: premaxilla edentulous (0); 1-4 (1); 5-6 (2); 7-20 (3); >20 (4)
 - Boundaries between states were determined by K means clustering
 - Lateral premaxillary teeth are specified due to the suggestion of premaxillary teeth on the medial process in *Haptodus* [3]
- 4) Number of lateral maxillary teeth: maxilla edentulous (0); 1-4 (1); 5-11 (2); 12-21 (3); >22 (4)
 - Boundaries between states were determined by K means clustering
 - In taxa with multiple tooth rows, only the lateral-most row is counted
- 5) Maxillary caniniforms present as single large member of tooth series (0); present as two or more enlarged members of tooth series (1); absent (2); or present as tusk (3).
 - Modified from [4], character 22
- 6) Number of postcanine maxillary teeth: 0 (0); 1-4 (1); 5-9 (2); 10-17 (3); >18 (4)
 - Boundaries between states were determined by K means clustering
- 7) Number of tooth rows in the maxilla: one (0); two to four (1); five (2); six or more (3), irregular pavement (4).
 - States from [5], character 9, and [6], character 133
- 8) If multiple rows present, number of teeth on maxillary dental field is: Less than 40 (0); 40 or more (1).
 - Modified from [5], character 7
- 9) If multiple rows of maxillary teeth present, double row of teeth extends far anteriorly on maxilla: absent (0); present (1).
 - Modified from [5], character 11
- 10) Number of lateral dentary teeth: dentary edentulous (0); 1-9 (1); 10-20 (2); 20-34 (3); >35 (4)
 - Boundaries between states were determined by K means clustering
 - In taxa with multiple tooth rows, only the lateral-most row is counted
- 11) Dentary, number of tooth rows: one (0); two (1); more than two (2)
 - [1], character 279
- 12) Dentary: caniniform teeth absent (0); caniniform region present anteriorly (1); Single caniniform tooth present anteriorly (2)
 - [5], character 56
- 13) Dentary postcanines: present (0); absent (1).
 - [7], character 44

- 14) Lower precanine number: 0 (0); 1 (1); 2-3 (2); 4 (3); >5 (4)
- Boundaries between states were determined by K means clustering
- 15) Dental tooth wear: absent (0); present, modest (1); present, saddle-shaped (2); present, produces cutting ridges (3).
- Modified from [5], character 12
 - Character state 3 new
- 16) Premaxillary tooth proportions: anteriormost tooth approximately same size as other teeth (0); anteriormost tooth reduced relative to other premaxillary teeth (1); anteriormost tooth larger than other premaxillary teeth (2).
- Modified from [2], character 289
- 17) Premaxillary tooth morphology: relatively straight and conical (0); spatulate (1); transversely compressed and recurved (2); chisel shaped (3); bulbous and ogival (4), with broad flattened tip (5); fan shaped (6);
- States drawn from multiple matrices
 - State 5 new, representing the unique morphology found in *Anomocephalus*
 - The distinction between spatulate teeth and fan-shaped teeth has not been robustly defined in previous matrices (it has mostly been used in analyses of pareiasaurs) beyond representing antero-posterior lengthening of the tooth. A fan-shaped tooth is here distinguished from a spatulate tooth in the crown being antero-posteriorly longer than high
- 18) Location of premaxillary teeth lateral (0), medial (1)
- Modified from [4], character 8
- 19) Premaxilla, orientation of the tooth series of the occlusal surface of premaxilla in ventral view: approximately parasagittal (0); strongly transverse and anterior teeth covering each other in lateral view (1)
- [1], character 43
- 20) Premaxillary teeth with longitudinal facets or fluting: absent (0); present (1).
- Modified from [8], character 97
- 21) Procumbant anterior teeth: absent (0); present in the lower jaw only (1); present in both upper and lower jaws (2); Present in upper jaw only (3)
- Modified from [9], character 29
 - Character state 3 new
- 22) Premaxillary and anterior dentary teeth possess serrated cutting margins (0); are smoothly ridged (1).
- Modified from [10], character 100
- 23) Premaxillary teeth intermesh with anterior dentary teeth: absent (0), present in anteriormost premaxillary teeth (1), present in all premaxillary teeth (2).

- Modified from [11], character 62
- 24) Heel/ridge on premaxillary and anterior dentary teeth: absent (0); weak heel (1); strong heel (heel width 30% or more larger than the base of the tooth apex) (2); ridge narrowing towards the tip (3)
- Modified from [12], character 8
- 25) Premaxillary fangs: absent (0); present (1).
- Modified from [13], character 66
 - Distinct from character 16; premaxillary fang cannot be anteriormost tooth
 - Fang cannot be accounted for by a general trend towards larger teeth posteriorly; fangs have to be exceptionally enlarged tooth/teeth among other homogenously sized teeth
 - Since enlarged anterior dentary tooth/teeth is accounted for by dentary canine character, dentary fangs are not included, unlike in the original character.
- 26) Diastema between premaxillary and maxillary teeth: absent (0); present (1)
- [12], character 26
- 27) Maxilla, caniniform teeth size: less than twice the height of non-caniniform teeth (0); more than twice the height (1).
- [14], character 35
 - Where there are multiple caniniformes, use the largest
- 28) Maxillary caniniform curvature: straight or slightly recurved ($<50^\circ$) (0); strongly recurved ($>50^\circ$) (1); curves anteriorly (2)
- Modified from [12], character 7
 - State 2 new
- 29) Maxillary caniniform serrations: present (0), absent (1).
- [10], character 106
- 30) Prominent ridge running vertically along the labial surface of the dominant upper caniniform tooth: absent (0); present (1).
- Modified from [8], character 101
 - The original formulation of this character related to the presence of a deep groove on the canine and was supposed to represent the morphology observed in *Euchambersia*. However, the canine of *Euchambersia* does not possess a deep groove, rather a prominent ridge on the labial surface. The earliest descriptions make this clear both in drawings and text [15-17]. The assumption that the canine was grooved appears to have derived from a drawing by Lehman [18] where the shading makes the ridge appear to be a prominent groove.

- 31) Lower caniniforms: fits into choana (0); into fossa roofed by premaxilla and maxilla (1); passes anterior and external to upper canine (2); passes through fossa in skull roof so is visible dorsally (3).
- Modified from [11], character 66
 - State 3 new
- 32) Upper and lower canines: without heels (0); small heels present (1).
- [11], character 67
- 33) Postcanine diastema on upper jaw: absent (0), present (1)
- [11], character 68
- 34) Upper postcanine teeth confluent with premaxillary row medial to canine: absent (0), present (1).
- [11], character 71
- 35) Maxilla, posterior extent of lateral dentition: anterior to posterior orbit margin (0); ventral to postorbital bar (1); posterior to postorbital bar (2); anterior to orbital midlength (3).
- [14], character 30
 - In the absence of a temporal fenestra, the postorbital represents the postorbital bar
- 36) Number of maxillary positions ventral to the jugal: Three or less (0); four or more (1)
- [6], character 138
- 37) Axis of posterior part of maxillary tooth row: directed lateral to subtemporal fossa (0), directed toward centre of fossa (1), directed toward medial rim of fossa and curved (2)
- [10], character 107
- 38) Maxilla, secondary enlargement of teeth posterior to caniniforms, if present: absent (0); present (1).
- [14], character 39
- 39) Maxilla, non-caniniform tooth morphology: relatively straight and conical (0); spatulate (1); transversely compressed and recurved (2); chisel shaped (3); bulbous and ogival (4); molariform, bucco-lingually expanded (5); sectorial with incipient lingual cingulum (6); sectorial with a well-developed lingual cingulum (7), fan-shaped (8).
- States drawn from multiple matrices
 - See note from character 17 on the distinction between spatulate and fan-shaped teeth
- 40) Non caniniform maxillary dentition, recurvature: completely absent (0); at least slightly recurved (1), strongly recurved, apex approximately 80-90 degrees from vertical (2).

- Modified from [14], character 41
- 41) Posterior-most maxillary teeth canted posterolaterally relative to more anterior teeth: absent (0); present (1)
- Modified from [12], character 6
- 42) Non-caniniform maxillary teeth located near lateral margin of maxilla (0); located more medially (1)
- Modified from [4], character 23
- 43) Posterior dentary teeth: same size as non-caniniform maxillary teeth (0); larger than non-caniniform maxillary teeth (1); smaller than non-caniniform maxillary teeth (2)
- Modified from [2], character 333
- 44) Posterior extent of mandibular and maxillary tooth rows: subequal (0); maxillary teeth extending further posteriorly (1); mandibular teeth extending further posteriorly (2)
- Modified from [1], character 298
 - Character state 2 new
- 45) Non caniniform maxillary and posterior dentary alveolar ridges: straight (0); twisted (helical), distal teeth inclined laterally (1).
- [14], character 31
- 46) Serrated carinae on the non-caniniform maxillary and posterior dentary teeth: absent (0); distinctly present on the mesial margin only (1); distinctly present on the distal margin only (2); present and distinct on both margins (3)
- Modified from [1], character 304
 - Character state 1 new
- 47) Non-caniniform maxillary teeth: serrated cusps antero-posteriorly orientated relative to the long axis of the tooth (0); serrations angled anterolingually-posterolabially (1).
- Modified from [12] character 4
- 48) Non-caniniform maxillary teeth, denticles: density high, 14–24 denticles/mm (0); denticle density low, <10 serrations/mm (1).
- Modified from [14], character 43
 - Taxa without serrations scored as inapplicable
- 49) Presence of denticles on non-caniniform maxillary and dentary teeth independent of carinae: absent (0), present (1).
- [14] character 245
- 50) Non caniniform maxillary teeth, number of apical cusps; one (0); central cusp, additional labial and lingual cusps poorly developed, represented by shoulders (1); labial and lingual cusps well developed in addition to central cusp (2); transverse crest with two cusps (3); transverse crest with more than two cusps (4); two-four cusps

arranged longitudinally (5); five-seven cusps arranged longitudinally (6); more than seven cusps arranged longitudinally (7); multiple cusps arranged around the edge of the crown (8)

- States drawn from multiple matrices
- Character state 8 new

51) If present, position of upper transverse cusp row on crown of non-caniniform maxillary teeth: on anterior half of crown (0); midcrown almost to posterior margin (1)

- Modified from [10], character 114

52) If transverse row present, central cusp is: absent (0), midway between buccal and lingual cusps (1), close to labial cusp (2)

- Modified from [10], character 115

53) If multiple cusps arranged longitudinally, is upper posterobuccal accessory cusp: present (0), absent (1).

- [10], character 118

54) If multiple cusps arranged longitudinally, is upper anterolingual accessory cusp: absent (0), present (1).

- [10], character 119

55) Where present, upper anterior transverse (cingulum) ridge: low (0), high (1).

- Modified from [10], character 120

56) Cutting ridge on lingual surface of molars: absent (0), present (1).

- [10], character 121

57) Non-caniniform maxillary and dentary teeth orientation: vertical (0); turned lingually (1); turned labially (2)

- Modified from [2], character 64
- Character state 2 new

58) Dentary: tooth row greater than 50% of total jaw length (0); tooth row less than 50% of total jaw length (1)

- [2], character 76

59) Teeth present on dorsal surface of dentaries (0); medially displaced, sometimes on a swelling or shelf (1)

- [4], character 117

60) Lingual cingulum in posterior dentary teeth: absent (0), small (1), well developed (2).

- Modified from [10], character 124

61) If present, cingulum on dentary teeth denticulated: absent (0) or present (1)

- Modified from [4], character 119
- 62) Anterior dentary teeth: not with distinct shape from rest of tooth row (0); distinct division in morphology similar to that observed between premaxillary and maxillary teeth (1); bulbous base giving teardrop-shaped morphology (2); enlarged and incisiform (3).
- States taken from [4], character 120, and [14], character 33
 - Character state 1 new
 - Size related heterodonty not included in this.
- 63) Jaw symphysis terminates in dorsal platform bearing the anterior teeth elevated above level of posterior dentary ramus (0); Symphyseal region of lower jaw smoothly rounded and at same level as rest of dentary ramus in lateral view (1), with an upturned beak that is raised above the level of the dorsal surface of the jaw rami and has a scooped-out depression on its posterior surface (2), drawn into a sharp, spiky beak (3), or shovel-shaped beak with a rounded or squared-off edge and a weak depression on its posterior surface (4).
- Modified from [4], character 121
- 64) Dentary, caniniform tooth size: less than twice the height of post-canine teeth (0); more than twice the height (1).
- Modified from [19], character 22
- 65) Posterior dentary teeth: undifferentiated (0), differentiated into premolariforms and molariforms (1).
- Modified from [10], character 109
 - This differentiation is called “premolariforms and molariforms” for want of anything better but scoring of character state 1 should not be limited to those with mammal-like differentiation. The character is intended to indicate any posterior shape (not size) heterogeneity, and character 112 is used to indicate the actual morphology
- 66) Tall, dorsally-convex cutting blade on medial edge of dorsal surface of dentary absent (0) or present (1)
- [4], character 126
- 67) Degree of molarization of the largest preserved, midseries dentary cheek teeth: absent (0); low (mediolateral width:anteroposterior length and mediolateral width:height not >0.5) (1); high (2)
- [9], character 30
- 68) Number of lower cusps in transverse row, if present: 1 (0), 2 (1), 3 or more (2)
- [10], character 123
- 69) Widest lower cusp in transverse row, where present: lingual (0), buccal (1).
- [10], character 127

- 70) Lower posterior basin: absent (0), present (1).
- [10], character 126
- 71) Posterior dentary teeth occlusion with upper teeth: single-sided overlap (0); flat occlusion (1); occlude with palatine (2); maxillary teeth pass into spaces between dentary teeth (3)
- [1], Character 280
 - Character states 2 and 3 new
- 72) Parasphenoid cultriform process with shagreen (0), with patch of denticles (1), with denticle row or rows (2), smooth (3).
- [20], character 55
- 73) Parasphenoid, teeth on ventral plate: present along edges (0); present across width of plate, forming central denticle field (1); teeth absent from ventral plate (2).
- Modified from [14]
- 74) Vomerine tooth field: small denticles (0); large conical teeth (1); absent (2)
- Character states taken from [21] character 121 and [20] character 59
 - Note, vomerine tooth field is separate from anterolateral field of pterygoid, which sometimes extends onto the vomer
- 75) Organisation of vomerine teeth: Single row (0); single row but multiple teeth anterior to contact with pterygoid (1); multiple rows or field (2)
- Modified from [1], character 187
- 76) Vomerine fang(s): absent (0); present (1)
- Modified from [22], character 69
- 77) Palatine dental field: multiple rows with numerous teeth/denticles (0); single row with four or more teeth (1), single row with less than four teeth (2); restricted to palatine boss (3); absent (4).
- Modified from [13], character 140
 - Note: palatine dental field is separate from anterolateral teeth of pterygoid, which sometimes extend onto palatine
 - Character state 3 new
- 78) Palatine teeth size: larger than marginal teeth (0); equal to marginal (1); smaller than marginal (2).
- [2], character 81
 - To judge from the original scorings in [2], palatine fangs are included in this, so this policy is followed here
- 79) Dentition on palatine boss, if present: extensive (0); elongate single row (1); a few teeth in a restricted position (2).

- Modified from [7], character 10
- 80) Presence (0) or absence (1) of fangs on palatine
- [20], character 62
- 81) Bone texture of the palatine: primarily smooth, without evidence of keratinized covering (0); relatively smooth but with fine pitting and texturing suggestive of a keratinized covering (1); rugose and textured (2).
- [4], character 76
- 82) Ventral surface of pterygoid palatal ramus with radiating, densely spaced low ridges with denticle rows (0), with radiating sharp ridges with denticles (1), with densely spaced denticle rows radiating from posterior midlength of palatal ramus (2), with teeth in two distinct fields, one extending anteriorly, one laterally (3), with a single tooth field covering the width of the process (4), dense covering of large teeth forming tooth plates (5); edentulous (6); teeth restricted to medial ridge or boss (7); with teeth in three distinct fields, one directed anteriorly, one anterolaterally towards suture with palatine, one laterally towards suture with ectopterygoid (8).
- States drawn from [14], character 122, [20], character 47 and [1], character 195
 - Character state 7 and 8 new; note the midline field (T4) is treated separately from character state 7 (see notes for character 86). State 8 represents condition seen in *Brouffia* and *Australothyris*.
- 83) Pterygoid, number of rows on palatal process tooth field T2 (laterally extending): more than two or do not dispose on distinct rows (0); two rows parallel to each other (1); single row (2)
- Modified from [1] character 196
- 84) Pterygoid, number of rows on palatal process tooth field T3 (medial): more than two or not disposed in distinct rows (0); two parallel rows (1); single row (2)
- Modified from [1] character 197
- 85) Pterygoid, a row of teeth ramus on the medial edge of the anterior ramus (T4) larger than those the anterior ramus fields: absent (0); present (1)
- Modified from [1], character 199
 - The identification in the literature of field T4 appears thus far to have only been based on comparisons of size and arrangement relative to the T3 field; there don't appear to be any archosaurs with T4 but no T3.
 - This does not hold for other clades. Some pelycosaurs e.g. *Cotylorhynchus*, have uniformly large palatal teeth, with their T3 field forming a single row along the midline, so in appearance (and potentially functionally) their T3 field is more similar to the T4 field. The plesiomorphic diadectid *Orobates* has no teeth on the palatal ramus but a single row of large teeth along the pterygoid midline. While potentially analogous to the T4 field in archosaurs, the difficulty is that in more derived diadectids this is reduced to a midline of

denticles, so a distinction of being large and fanglike is not necessarily useful as far as homology goes.

- Solution: T4 field is defined relative to the T3 field, as previously in the archosaur literature i.e. this character can only be scored if the T3 field is present, otherwise should be treated as inapplicable. Character state 7 has been added to character 83 to represent the condition seen in diadectomorphs and some therapsids where the only pterygoid teeth are restricted to a midline ridge or boss (the T4 field in archosaurs is not elevated in such a way)

86) Pterygoid, teeth in anterolaterally oriented field: extends posteromedially to basicranial area (0); does not extend as far as basicranial area (1)

- Modified from [14], character 122

87) Pterygoid, teeth in anteriorly oriented field: extends anteriorly onto vomer (0); does not extend onto vomer (1)

- Modified from [20], character 70

88) Pterygoid, teeth in anterolaterally oriented field: extends laterally onto palatine (0); does not extend onto palatine (1)

- Modified from [20], character 71

89) Pterygoid, teeth in anterolaterally oriented field: extends laterally onto ectopterygoid (0); does not extend onto ectopterygoid (1)

- Modified from [20], character 72

90) Pterygoid, teeth arranged along posterior margin of ventral surface of pterygoid flange: present (0); absent (1).

- Modified [14], character 121

91) Pterygoid, teeth on transverse flange: shagreen of very small teeth (0); single row of large teeth (1); single row of large teeth, with a shagreen of very small teeth anterior to it (2); Durophagous plate (3)

- Modified from [22], character 71
- Character state 3 new

92) Quadrate flange of pterygoid dentition: absent (0); present (1).

- [22], character 72

93) Dentition on boss of pterygoid, if present: extensive (0); reduced (1).

- Modified from [7], character 13

94) Ectopterygoid field of teeth: present (0); absent (1)

- Multiple matrices
- Note: ectopterygoid dental field is separate from pterygoid tooth field, which sometimes extend onto ectopterygoid

- 95) Ectopterygoid teeth organised into row of three or more of teeth: present (0); absent (1).
- Modified from [2], character 284
- 96) Presence (0) or absence (1) of fangs on ectopterygoid
- [20], character 66
- 97) Denticle field on posterior coronoid absent (0) or present (1).
- [20], character 121
- 98) Denticle field on middle coronoid absent (0) or present (1).
- [20], character 120
- 99) Coronoid dentition, if present, forms organized tooth row: yes (0); no (1)
- Modified from [2], character 328
- 100) Coronoids: size of teeth on anterior and middle coronoids relative to dentary tooth size: (0) about the same; (1) half the height or less.
- [2], character 330
- 101) Separate field of denticles lining the exchoanal margin absent (0) or present (1).
- Modified from [20], character 73
- 102) Prearticular dentition absent (0) present (1)
- Modified from [20], character 106
- 103) Premaxillary tooth size: subequal to non-caniniform maxillary teeth (0); larger than non-caniniform maxillary teeth (1); Smaller than non-caniniform maxillary teeth (2)
- Modified from [11], character 64
 - Character state 2 new
- 104) Posteriormost dentary teeth occlude with the pterygoid teeth: absent (0); present (1)
- New
 - If either are edentulous, score inapplicable
- 105) Upper caniniform implantation, if present: almost vertical (0); emergent portion of tooth/teeth points anteriorly (1)
- New
- 106) Ventral bulging of tooth-bearing portion of maxilla ventrally offsets the maxillary tooth-row from the posteriormost pre-maxillary tooth: absent (0); present (1)
- Modified from [14]

- Rewording to distinguish the “precanine step” visible in, for example, sphenacodontids (ventral bulging of maxilla) from taxa where the premaxillary toothrow is offset by an upturning of the premaxilla, which sometimes also produces a step in the lateral margin of the upper jaw, but which causes procumbent premaxillary teeth and is therefore already incorporated into character 21. Note that the two are not mutually exclusive; the premaxillary tooth row may be dorsally offset from the maxillary tooth row both by ventral bulging of the maxilla and an upward turn of the premaxilla.
- 107) Premaxillary tooth row displaced ventromedially by downturned premaxilla: absent (0); present (1)
- Modified from [5]
 - Reworded to distinguish between the morphology observed in some archosaurs and captorhinids (where a downturned premaxilla changes the orientation of the teeth) and the toothless beak of some anomodonts (where a sharp ventral projection at the tip of the premaxilla forms the beak that itself represents the food processing equipment)
- 108) Diastema separating posteriormost maxillary tooth from those anterior to it: absent (0); present (1)
- New
- 109) Heel/ridge on non-caniniform maxillary and posterior dentary teeth: absent (0); present lingually, weak (1), present lingually, strong (2); present distally on upper jaw, medially on lower jaw (3); Ridge, narrowing towards the tip (4)
- New
 - Characters referring to heeled morphology of the entire tooth-row have been included in matrices referring to parareptiles (to account for the morphology in bolosaurids) but have not been included here due to the need to account for the pattern observed in some therapsids, where precanine and canine can have combinations heels, but no postcanine teeth with heels are observed. Therefore, an extra character is added to incorporate presence or absence of heels on maxillary teeth.
 - Character state 3 new represents the unique morphology observed in *Gansurhinus*
- 110) Lower premolar morphology: Conical (0); sectorial, with anterior and posterior accessory cusps (1); Bulbous (2); Spatulate (3); Molariform (4)
- New
- 111) Labial parapet on lower jaw: absent (0); low (not projecting higher than the bases of the cheek teeth (1); tall (as tall as the occlusal surface of the teeth) (2)
- [9]; character 22

- 112) Anteriormost tooth-bearing portion of the maxilla turns dorsally, so that the anterior maxillary teeth are directed anteriorly: absent (0); present (1)
- New
- 113) If maxillary/premaxillary tooth-row offset present due to ventral bulging of maxilla, caniniform (if present) is posterior to step (0); anterior to step (1)
- New
- 114) Row of enlarged teeth on lateral margin of palatal process of pterygoid: absent (0); present (1)
- New

Supplementary Dataset 2

Source Trees for supertree

Backbone: [2]

Seymouriamorpha: [20]

Diadectomorpha: [23]

Stem Eureptiles: [21,24-26]

Archosauromorpha: [1,27,28]

Lepidosauromorpha: [29]

‘Euryapsids’: [6,13,30,31]

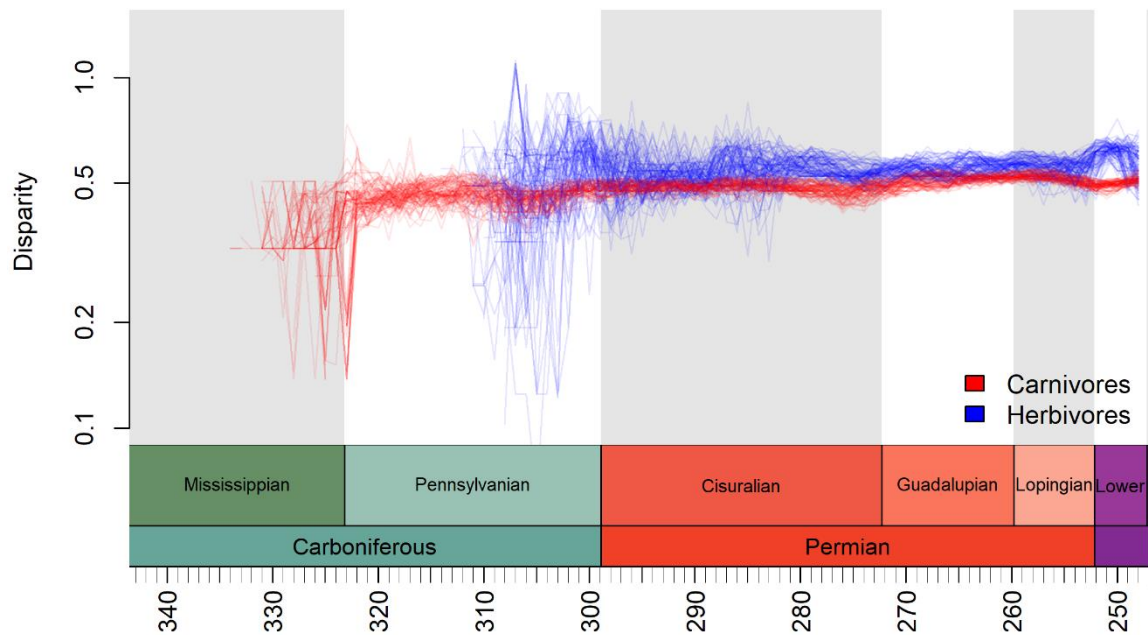
Parareptilia: [32-38]

‘Pelycosaurs’: [14,39-43]

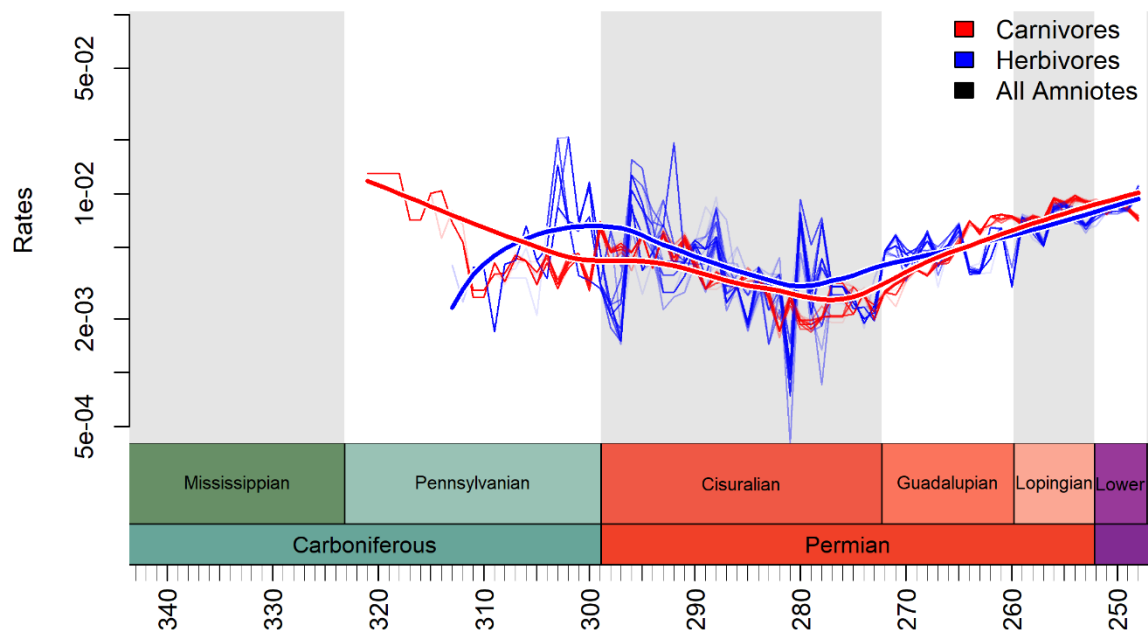
Therapsida: [4,7,8,11,12,19,44,45]

Microsauria: [46,47]

Supplementary Figures



Supplementary Figure 1: Dental disparity of faunivorous (red) and herbivorous (blue) amniotes, obtained analysing the supertree based on the backbone relationships of Ford & Benson [48]. Each thin line represents results from one stochastic map used to assign a diet to each branch in one selected tree from the Bayesian posterior distribution.



Supplementary Figure 2: Rates of dental evolution of faunivore (red) and herbivorous (blue) amniotes, obtained analysing the supertree based on the backbone relationships of Ford & Benson [48]. Thin lines represent rates inferred from the maximum clade credibility tree. Each thin line represents results from one stochastic map used to assign a diet to each branch. The thick lines represent Loess fitted regression curves.

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