Supplementary data

CHARACTER LIST

List of characters used in the phylogenetic analysis. Capital letters "T", "R", and "L", refer to characters used by Tchernov et al. (2000), Rieppel, et al. (2002), and Lee and Scanlon (2004), respectively, followed by the character number used by the authors.

Dentition

1. Tooth implantation on the dentary pleurodont (0), Alethinophidian (1) (*sensu* Zaher and Rieppel, 1999) [R1]. This character is coded according to the condition present on the posterior part of the dentary of snakes and lizards.
2. Enamel surface (except for presence of anterior and posterior cutting edges) smooth (0), distinctly ridged (striated) (1) [R3, L172].
3. Maxillary and dentary teeth relatively short conical and upright (0), robust and recurved (1), elongate needle-shaped, and distinctly recurved (2) [R4].
4. Premaxillary dentition with teeth (0), without teeth (1) [T1, L173].
5. Alveoli and base of teeth not expanded transversely (0), wider transversely than anteroposteriorly (1) [L178].

Skull

6. Transverse processes of premaxilla distinctly curved backwards (0), or extending straight laterally (1) [L11].
7. Dorsal (horizontal) lamina of nasal relatively broad anteriorly, leaving a narrow gap between its lateral margin and the vertical flange of the septomaxilla (0), or dorsal

lamina of nasal distinctly tapering anteriorly, leaving a wide gap between its lateral margin and the vertical flange of the septomaxilla (1) [T4, L25].

8. Vertical medial flanges of nasal do (0), or do not (1) articulate with the medial frontal pillars [T5].

9. The posterior dorsal process of the lateral vertical flange of the septomaxilla is absent (0), short (1), or long (2) [T6, L80].

10. The septomaxilla does not (0), or does (1) articulate with the medial frontal pillars [T&, L82].

11. Ventral portion of posterior edge of lateral flange of the septomaxilla is located at the level of the posterior edge or behind (0), or distinctly in front (1) of the opening of Jacobson's organ [T8, L80]. Contrary to Lee and Scanlon (2004), we consider this character distinct from character 9.

12. Vomeronasal cupola fenestrated medially (0), or closed medially by a sutural contact of septomaxilla and vomer (1) [T9, L86].

13. The septomaxilla forms the entire lateral margin of the opening of Jacobson's organ (0), or the vomer extends into the posterior part of the lateral margin, restricting the septomaxilla to the anterolateral part of the lateral margin of the opening of Jacobson's organ (1) [T10, L84].

14. The vomeronasal nerve does not pierce the vomer (0), enters the vomer through a single large foramen (or an additional one or two smaller foramina) (1), or through a cluster of small foramina (2) [T11, L85].

15. Posterior ventral (horizontal) lamina of vomer long, parallel edged (0), or short, tapering to a pointed tip (1) [T12, L88].

16. Posterior dorsal (vertical) lamina of vomer well developed (0), or reduced or absent [T13, L89].

17. Outer orbital (lateral) margin of the prefrontal is slanting anteroventrally (0), or is positioned vertically (1) [T14, L39].
18. The lacrimal foramen is located between the prefrontal and the maxilla (0), or is completely enclosed by the prefrontal (1) [T15, L45].
19. The lateral foot process of the prefrontal contacts the maxilla only (0), or the maxilla and the palatine (1), or the palatine only (2) [T16, L36].
20. The medial foot process of the prefrontal (*sensu* Frazzetta, 1966: fig. 18) is absent (0), low (1), or high (2) [T17].
21. Anterior / lateral flange of prefrontal, covering the nasal gland and roofing the aditus conchae, is absent (0), or well developed (1) [T19].
22. The ventral margin of the lateral surface of the prefrontal articulates along its entire length with the dorsal surface of the maxilla (0), or retains only a posterior contact (1) (i.e., at the anteroventral corner of the orbit) [T22, L34].
23. The dorsal lamina of the prefrontal contacts or forms an overlapping contact with the nasal posteromedially (0), or remains separate from the nasal (1) [T23, L33].
24. Medial frontal pillars absent (0), present (1) [T24, R54, L56]. *Wonambi* is coded according to Scanlon's (2005) description.

25. Preorbital ridge distinct and well defined (0), or poorly defined or absent (1) [T20, L53].
26. Supraorbital absent (0), or present (1) [T25]. *Dinilysia* is coded as having a supraorbital (1) because we consider the postfrontal to be absent in alethinophidians.
27. Postorbital present (0), or absent (1) [T26, L47].
28. Ventral tip of postorbital remains separated by a wide gap from ectopterygoid (0), or it touches (in dried skulls), or closely approaches the ectopterygoid, forming an almost complete posterior margin of the orbit (1) [T27, L51].

29. The dorsal head of the postorbital is simple (0), or bifurcated (1) [T28, L48].
30. Parietal without lateral wings meeting postorbital bones (0), or with lateral wings meeting postorbital bones (1) [R14].
31. Distinct lateral ridge of parietal extending posteriorly from anterior lateral wing up to prootic present (1), or absent (1) [R15].
32. Sagital crest of the parietal absent (0), present, low in its posterior part that merges into weakly anteriorly diverging ridges (1), present, prominent and merges into anterolaterally curving ridges at anterior end of parietal (2) [R16].
33. Fronto-parietal suture relatively straight (0), or distinct supraorbital process of parietal extends along at least 50% of the length of dorsal margin of orbit (1) (i.e., fronto-parietal suture U-shaped) [T32, L63].
34. The parietal margin of the optic foramen is straight (0) (i.e., the parietal is not notched by the optic foramen), or concave (1) (i.e., the parietal is notched by the optic foramen) [T33, L61].
35. Supratemporal processes of parietal distinctly developed (0) (i.e., parietal expanded at level of jaw suspension), or not distinctly developed (1) [T34, L66].
36. Parietal does not (0), or does (1) enter the anterior aspect of the base of the basipterygoid process along its entire width [T36, L68].
37. Contact between parietal and supraoccipital is V-shaped with the apex pointing anteriorly (i.e., the parietal is embayed posteriorly) (0), or is essentially a straight transverse line (1), or is V-shaped with the apex pointing posteriorly (i.e., posteriorly pointed) (2) [T37, L64, L65].
38. Ascending process of the maxilla present (0), absent (1) [T29, L14, R5].
39. Anterior end of maxilla strait or only weakly bent inwards (0), or distinctly curved inward (1) [R6].

40. Small horizontal shelf on medial surface of anterior end of maxilla present (0), absent (1) [L15, R7]

41. Posterior end of maxilla does not project beyond posterior margin of orbit (0), projects moderately beyond posterior margin of orbit (1), projects distinctly beyond posterior margin of orbit, with broad flat surface (2) [R8]. Differently from Rieppel et al. (2002), we do not anymore consider character state 2 correlated with a broad, smooth and loose overlap of the ectopterygoid and maxilla.

42. Medial (palatine) process of maxilla located in front of the orbit (0), or located below the orbit (1) [R9].

43. Medial palatine process of maxilla pierced (0), or not pierced (1) [T30, L21].

44. Anterior end of supratemporal (facet) located behind or above posterior trigeminal foramen (0), or in front of posterior trigeminal foramen (1) (T40, L72, R30].

45. Supratemporal facet on opisthotic-exoccipital flat (0), or sculptured and delineated with projecting posterior rim that overhangs exoccipital (1) [R31].

46. Free-ending posterior process of supratemporal absent (0), present (1) [T39, L70, R32].

47. Supratemporal present (0) or absent (1) [T38, L69]. *Najash* and *Wonambi* are coded as having supratemporals because they retain evidence, respectively, of a recess and a facet in the dorsolateral surface of their skull which receiving the supratemporal.

48. Anterior dentigerous process of palatine absent (0), present (1) [T41, L94, R10].

49. Medial (choanal) process of palatine forms an extensive concave surface dorsal to the ductus nasopharingeus (0), narrows abruptly to form a curved finger-like process (1), or forms a short horizontal lamina that does not reach the vomer (2) [T48, L92, R11]

50. Pterygoid contacts palatine in more or less complex pattern with clasping projections (0), in tongue-in-groove joint (1), or palatine-pterygoid contact reduced to flap-overlap (2) [R12].

51. Palatine does (0), or does not (1) contact the ectopterygoid [T42].

52. The dentigerous process of the palatine meets the vomer and/or septomaxilla posterolateral to the opening of Jacobson's organ (0), or fails to do so (1) [T43].

53. Lateral (maxillary) process of palatine is situated anterior to the posterior end of palatine (0), or at the posterior end of the palatine (1) [T44, L97].

54. Lateral (maxillary) process of palatine in well defined articulation (0), or only loosely overlapping the medial (palatine) process of maxilla, or no articulation between palatine and maxilla (1) [T45, L96].

55. Maxillary branch of trigeminal nerve pierces the lateral (maxillary) process of the palatine (0), or it passes dorsal between the palatine and the prefrontal (1) [T46, L98].

56. The vomerine process of the palatine curves medially and meets the vomer in a well defined articular facet (0), or it touches or abuts the vomer without articulation or remains separated from vomer (1) [T47, L90].

57. Internal articulation of palatine with pterygoid short (0), or long (1) [T49, L99].

58. Pterygoid teeth absent (0), present (1) [T50, R13].

59. Quadrate ramus of pterygoid robust, rounded or triangular in cross-section, but without groove (0), or blade-like and with distinct longitudinal groove for the insertion of the protractor pterygoidei muscle (1) [T51, L105].

60. Transverse (lateral) process of the pterygoid forms a distinct, well defined lateral projection which receives the ectopterygoid on its anterior dorsal surface (0), or the transverse process is a gently curved lateral expansion of the pterygoid which receives the ectopterygoid mostly on its lateral surface (1), or on its dorsal surface (2) [T52, 101, L109].

61. The lateral edge of the ectopterygoid is straight (0), or angulated (1) [T53, L113].

62. Anterior end of ectopterygoid restricted to posteromedial edge of maxilla (0), or invades significantly the dorsal surface of the maxilla (approaching the posteroventral corner of the orbit) (1) [T54, L111, L112]. *Wonambi* is coded according to the description given by Scanlon (2005).
63. Pterygoid attached to basicranium by strong ligaments at palatobasal articulation (0), or pterygoid free from the basicranium in dried skulls (i.e. supported by cid-muscles) (1) [T83].
64. Quadrate slender (0), or broad, with a rectangular shape (1).
65. Quadrate slanted anteriorly (cephalic condyle positioned behind mandibular condyle (0), or positioned vertically (1), or slanted posteriorly (cephalic condyle positioned in front of mandibular condyle) (2) [T55, L78].
66. Cephalic condyle of quadrate elaborated into posteriorly projecting suprastapedial process (0), or suprastapedial process absent or vestigial (in the adult) (1) [T56].
67. Stylohyal (dorsal tip of dorsal stapedial process) fuses to the posterior tip of the suprastapedial process of quadrate (0), or it fuses to the ventral aspect of a reduced (embryonic) suprastapedial process (1), or the stylohyal fuses directly to the shaft of the quadrate (2) [T59, L73, L146].
68. Stapedial shaft straight (0), or angulated (1) [T60, L144].
69. Stapedial shaft slender and longer than diameter of stapedial foot-plate (0), or thick, and equal to, or shorter than diameter of stapedial foot-plate (1) [T61, L145].
70. Paroccipital process of opisthotic underlying supratemporal present (0), reduced to short projection separated from exoccipital by deep notch (1), absent (2) [T73, L137, R33].
71. Juxtastapedial recess, defined by crista circumfenestralis absent (0), present but open posteriorly (1), or present and closed posteriorly (2) [T74, L135, R34].

72. Crista circumfenestralis exposes most of stapedial footplate (0), converges upon stapedial footplate (1) [R35].

73. Crista interfenestralis does not form individualized component in ventral rim of crista circumfenestralis (0), does form individualized component in ventral rim of crista circumfenestralis (1) [R36]

74. Jugular foramen exposed in lateral view by crista tuberalis (0), concealed in lateral view by crista tuberalis (1) [R37]

75. Exoccipitals do not contact each other dorsally (0), contact each other dorsally (1).

76. Supraoccipital with narrow (i.e., less than parietal) (0), or broad (i.e., as long as or more than parietal) contact to prootic (1) [T62, L140].

77. Prootic does not exclude parietal from trigeminal foramen (0), does exclude parietal from trigeminal foramen (1) [T70, L132, R27]

78. Laterosphenoid absent (0), present (1) [T65, L130, R28]. This character is coded as unknown in *Wonambi* due to the uncertainties regarding the presence of the laterosphenoid in this snake (see Rieppel et al., 2002; Scanlon, 2005)

79. Posteriorly undercut prootic ledge underlap posterior trigeminal foramen absent (0), present (1) [R29]

80. Prootic exposed in dorsal view medial to the supratemporal or to supratemporal process of parietal (where supratemporal is lacking) (0), or fully concealed by the supratemporal or parietal in dorsal view (1) [T66, L136].

81. Exit foramen for the hyomandibular branch of the facial nerve is located outside (0), or inside (1) the opening for the mandibular branch of the trigeminal nerve [T67, L133].

82. Vidian canal does not open intracranially (0), open intracranially (1) [R17].

83. Anterior opening of Vidian canal single (0), divided (1) [R18].

84. Sella turcica bordered posteriorly by well developed dorsum sellae (0), dorsum sellae low (1), dorsum sellae not developed, sella turcica with shallow posterior margin (2) [R20]

85. "Lateral wings of the basisphenoid" absent (0), present (1) [T79, L119, R21].

86. Ventral surface of the basisphenoid smooth (0), with weakly developed sagital crest from which protractor pterygoidei originates (1), with strongly projecting sagital crest (2) [T77, L120, R22].

87. Basisphenoid-basioccipital suture smooth (0), transversely crested (1) [R23].

88. Basipterygoid processes present (0), absent (1) [T82, L117, R24]. Following arguments in Rieppel et al. (2002: 827), basipterygoid processes are here viewed as homologous in both outgroup and ingroup.

89. Crista trabeculares short and or indistinct (0), elongate and distinct in lateral view of the basisphenoidal rostrum (1) [R25].

90. Para-basisphenoidal rostrum behind optic foramen narrow (0), broad (1) (T80, L115, R26].

91. Basioccipital meets para-basisphenoid in a suture located at the level of the fenestra ovalis (0); or located at level of trigeminal foramen (foramina) (1) [T78, L121].

92. Parasphenoid rostrum without (0), or with broad based (1), or narrow based (2) interchoanal process [T80, L115].

Mandible

93. Posterior dentigerous process of dentary absent (0), present and short (1), present and long (2) [T87, L149, R38].

94. Medial margin of adductor fossa relatively low and smoothly rounded (0), forms a distinct dorsally projecting crest (1) [T88, L166, R39]. Differently from Tchernov et al. (2000)

and Rieppel et al. (2002), we code *Pachyrhachis*, *Haasiophis*, and *Eupodophis* with state (0) instead of (1).

95. Mental foramina on lateral surface of the dentary two or more (0), one (1).

96. Coronoid process of coronoid bone high, tappering distally (0), high, with a rectangular shape (1), low, not exceeding significantly the coronoid process of the compound bone (2) [T86, L164].

97. Coronoid bone present (0) absent (1) [T84, L160].

98. Posteroventral process of the coronoid present (0), absent (1) [T85, L161].

99. Coronoid process on lower jaw formed by coronoid bone only (0), or by coronoid and compound bone (1), or by compound bone only (2) (i.e., coronoid absent) [T86, L164].

Vertebrae

100. Chevrons present (0), absent (1) [41]. *Wonambi* is coded as unknown for this character because we consider that the only, isolated, caudal vertebra with a chevron bone assigned to this taxon by Scanlon and Lee (2000) represents a questionable record.

101. Hemapophyses absent (0), present (1) [R42].

102. Para-diapophysis confluent (0), separated into dorsal and ventral facet (1) [R43].

103. Prezygapophyseal processes absent (0), present (1) [R44].

104. Subcentral foramina absent (0), present and consistently small (1), present, of variable size (2) [R45].

105. Second (axis) intercentrum not fused to anterior region of axis centrum, suturally connected at most (0), fused to anterior region of axis centrum (1) [L189].

106. Neural spine height, a well-developed process (0), low ridge or absent (1) [L190].

107. Posterior margin of neural arch shallowly concave in dorsal view (0), with deep V-shaped embayment in dorsal view exposing much of centrum in front of condyle (1) [L191].

108. Condyles of mid-trunk vertebrae oval (0), round (1) [L193].

109. parazygantral foramen absent (0), present (1) [L198].

110. Lymphapophyses absent (0), present (1).

111. Lymphapophyses, three or fewer (0), three lymphapophyses and one forked rib (1), more than three lymphapophyses and one forked rib (2) [L203].

112. Sacral vertebrae present (0), absent (1).

113. Position of synapophyses in relation to lateral edge of prezygapophyses at the same level or slightly more projected laterally (0), clearly medial to the edge of the prezygapophyses (1).

114. Pachyostotic vertebrae absent (0), present (1).

Hindlimbs

115. Trocanter externus present (0), absent (1).

116. Pelvis external to sacral-cloacal rib (0), internal to sacral-cloacal ribs (1).

117. Ilium and pubis length, ilium longer than pubis (0), ilium and pubis of same size (1), pubis much longer than ilium (2).

118. Pelvic elements with strongly sutured contact (0), with weak (cartilaginous) contact (1), fused together (2).

119. Pelvic elements present (0), absent (1).

DATA MATRIX

This data matrix is in Nexus/PAUP* 4.0 format. It can be run by pasting it into a new PAUP file and executing it.

#NEXUS

[MacClade 4.06 registered to Hussam Zaher, Universidade de São Paulo]

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Basal_colubroids

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Eupodophis

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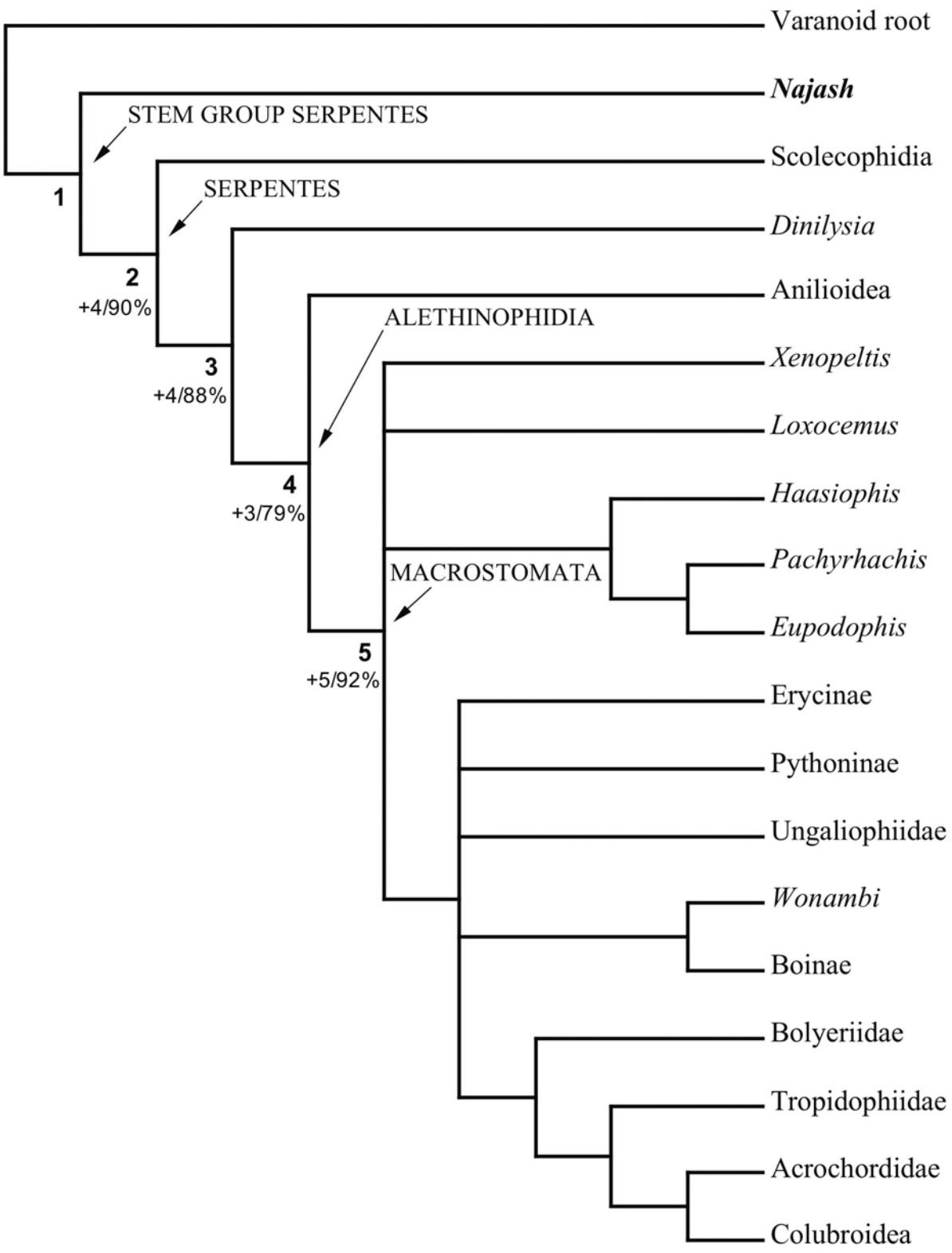

Strict consensus of two equally parsimonious trees (tree length of 270 steps, ensemble consistency index of 0.526, and retention index of 0.654). A list of apomorphies for each numbered node (1 to 5) is given below. Bremer support and Bootstrap percentages are given in the nodes.

List of apomorphies for the successive nodes numbered from one to five (under ACCTRAN optimization). **1. Stem group Serpentes**: Premaxilla without teeth; dorsal (horizontal) lamina of nasal relatively broad anteriorly, leaving a narrow gap between its lateral margin and the vertical flange of the septomaxilla; medial foot process of the prefrontal low; ventral tip of postorbital contacts (in dried skulls), or closely approaches the ectopterygoid, forming an almost complete posterior margin of the orbit; posterior end of maxilla projects moderately beyond posterior margin of orbit; maxillary branch of the trigeminal nerve passes dorsally between the palatine and the prefrontal; lateral edge of the ectopterygoid is strait; stapedial shaft angulated; stapedial shaft thick and equal to, or shorter than the diameter of the stapedial foot-plate; paroccipital process of the opisthotic underlying the supratemporal absent; Juxtastapedial recess defined by crista circunfenestralis open posteriorly (ci = 1.0); Vidian canal open intracranially; dorsum sellae not developed, sella turcica with a shallow posterior margin; broad para-basisphenoidal rostrum behind optic foramen; chevrons absent; hemapophyses present; para-diapophyses separated into dorsal and ventral facets; neural spines absent or formed by a low ridge; lymphapophyses present; ilium and pubis of same size (ci = 1.0). **2. Serpentes**: supratemporal processes of parietal not distinctly developed; contact between parietal and supraoccipital is essentially a straight transverse line; exoccipitals contact each other dorsally; prezygapophyseal processes present; second (axis) intercentrum fused to anterior region of axis centrum; presence of three lymphapophyses and one forked rib; sacral vertebrae absent (ci = 1.0); synapophyses in a position clearly medial to the lateral edge of the prezygapophyses; trocanter externus absent (ci = 1.0); pelvis internal to

ribcage (ci = 1.0). **3. *Dinilysia* plus Alethinophidia**: tooth implantation on the dentary of alethinophidian type (ci = 1.0); maxillary and dentary teeth robust and recurved (ci = 1.0); posterior dorsal process of the lateral vertical flange of the septomaxilla short; vomeronasal nerve enters the vomer through a single large foramen (or an additional one or two smaller foramina) (ci = 1.0); outer orbital (lateral) margin of the prefrontal positioned vertically; sagital crest of the parietal present, low in its posterior part that merges into weakly anteriorly diverging ridges; palatine does not contact the ectopterygoid (ci = 1.0); pterygoid teeth present (ci = 1.0); quadrate positioned vertically (ci = 1.0); crista interfenestralis forms individualized component in ventral rim of the crista circumfenestralis; crista trabeculares elongate and distinct in lateral view of the basisphenoidal rostrum; posterior dentigerous process of dentary present and short (ci = 1.0); one mental foramen on lateral surface of dentary. **4. Alethinophidia**: medial frontal pillars present (ci = 1.0); fronto-parietal suture U-shaped, with distinct supraorbital processes of the parietal extending along at least 50% of the length of dorsal margin of orbit; parietal enters the anterior aspect of the base of the basipterygoid process along its entire width (ci = 1.0); anterior end of maxilla distinctly curved inward; anterior dentigerous process of palatine present (ci = 1.0); contact between palatine and pterygoid in tongue-and-groove joint (ci = 1.0); internal articulation of palatine with pterygoid long; anterior end of ectopterygoid invades significantly the dorsal surface of the maxilla (approaching the posteroventral corner of the orbit); laterosphenoid present (ci = 1.0); exit foramen for the hyomandibular branch of the facial nerve is located inside the opening for the mandibular branch of the trigeminal nerve; lateral wings of the basisphenoid present (ci = 1.0); para-basishpenoidal rostrum behind optic foramen narrow; parasphenoid rostrum with broad based interchoanal process; coronoid process of coronoid bone low, not exceeding the coronoid process of the compound bone; coronoid process on lower jaw formed by coronoid and compound bone. **5. Macrostomata**: maxillary and dentary teeth elongate,

needle-shaped, and distinctly curved (ci = 1.0); alveoli and base of teeth not expanded transversely; dorsal laminae of nasal distinctly tapering anteriorly, leaving a wide gap between its lateral margin and the vertical flange of the septomaxilla; posterior dorsal process of lateral vertical flange of septomaxilla long; vomeronasal cupola closed medially by a sutural contact of septomaxilla and vomer (ci = 1.0); parietal margin of the optic foramen concave (i.e., the parietal is notched by the optic foramen); contact between parietal and supraoccipital is V-shaped with the apex pointing anteriorly (i.e., the parietal is embayed posteriorly); ascending process of maxilla absent; posterior end of the maxilla projects distinctly beyond posterior margin of orbit, with broad flat surface; medial palatine process of maxilla not pierced; free-ending posterior process of supratemporal present (ci = 1.0); medial (choanal) process of palatine narrows abruptly to form curved finger-like process; lateral (maxillary) process of palatine only loosely overlapping the medial (palatine) process of maxilla, or no articulation between palatine and maxilla (ci = 1.0); quadrate ramus of pterygoid blade-like and with distinct longitudinal groove for the insertion of the retractor pterygoidei muscle; transverse (lateral) process of the pterygoid is a gently curved lateral expansion which receives the ectopterygoid mostly on its lateral surface; lateral edge of the ectopterygoid angulated; suprastapedial process of quadrate absent or vestigial (in adult); stylohyal fuses to the ventral aspect of a reduced (embryonic) suprastapedial process; stapedial shaft slender and longer than diameter of stapedial foot-plate; prootic fully concealed by the supratemporal or parietal in dorsal view (ci = 1.0); dorsum sellae low; ventral surface of the basisphenoid with weakly developed sagital crest from which protractor pterygoidei originates; basiociipital meets para-basisphenoid in a suture located at the level of trigeminal foramen (foramina); parasphenoid rostrum with narrow based interchoanal process; posterior dentigerous process of dentary present and long (ci = 1.0); posteroventral

process of coronoid absent; more than three lymphapophyses and one forked rib; pelvic elements fused together.