Appendix

This list of 370 characters is that compiled for the phylogenetic analysis of Pardo et al., 2017. Their original character numbers are retained, with text edited for consistent punctuation and capitalization. The original source of individual characters within the list is noted via an acronym as per Pardo et al.:

**CABF**: Clack, Ahlberg, Blom, and Finney (2012)

**HPSA**: Huttenlocker, Pardo, Small, and Anderson (2013)

**MA**: Maddin & Anderson (2012)

**PSAA**: Pardo, Szostakiwskyi, Ahlberg, and Anderson (2017)

Modifications of a few character states to accommodate Whatcheeria are noted as **BL:** Bolt & Lombard

States determined for Whatcheeria are in **bold**. Characters where a state for Whatcheeria might be determined with better specimens, or have yet to be determined where work is in progress, are indicated as **Not** **determinable**. Characters where no state listed fits Whatcheeria are indicated as **Not applicable**.

1. Basal Skull Length **(HPSA 001): (0) >70mm**; (1) 50-70mm; (2) 30-50mm; (3) <30mm.

2. Skull:trunk ratio **(HPSA 002):** (0) 0.45; (1) 0.30-0.45; (2) 0.20-0.29; (3) 0.20 **Not** **determinable**.

3. Skull proportions **(HPSA 003): (0) longer than wide**; (1) wider than long.

4. Intertemporal **(PSAA 4): (0) present**; (1) replaced by anterior extension of supratemporal or tabular; (2) replaced by lateral extension of parietal. (**PSAA** **note: this character serves as a replacement for HPSA 004, 007, 008, 050, 051, and 052)**

5. Supratemporal **(HPSA 005): (0) present**; (1) absent.

6. ST exposure on occiput **(HPSA 006): (0) absent;** (1) present.

7. Postfrontal shape **(HPSA 009):** (0) broadly quadrangular; **(1) falciform**.

8. Squamosal-Tabular contact **(HPSA 010): (0) absent;** (1) present; (2) fused.

9. Lacrimal-prefrontal suture **(HPSA 012):** (0) simple butt joint; (1) interdigitating; (2) prefrontal broadly underplates lacrimal. **Not determinable.**

10. Lacrimal **(HPSA 013): (0) present**; (1) absent.

11. Lacrimal extends to naris **(HPSA 014)**: **(0) present**; (1) absent.

12. Lacrimal extends to orbit **(HPSA 015): (0) absent;** (1) present.

13. Lacrimal orbital processes **(HPSA 016):** (0) only ventral present; (1) dorsal and ventral present; (2) neither present. **Not applicable.**

14. Lacrimal-jugal contact **(HPSA 017): (0) present**; (1) absent.

15. Quadratojugal **(HPSA 018): (0) present**; (1) absent.

16. Quadratojugal-jugal contact **(HPSA 019)**; **(0) present**; (1) absent.

17. Quadratojugal-Maxillary contact **(HPSA 020):** (0) present; (1) absent. **Not determinable.**

18. Frontals **(HPSA 021): (0) paired**; (1) fused.

19. Frontal into orbital margin **(HPSA 022): (0) no**; (1) yes.

20. Anterior laterally flaring frontals **(HPSA 023): (0) absent;** (1) present.

21. Nasals **(HPSA 024): (0) present**; (1) absent.

22. Narial flange **(HPSA 025): (0) absent;** (1) present.

23. Alary processes of premaxilla **(HPSA 026):** (0) absent; (1) present.

24. Septomaxilla **(HPSA 028): (0) ossified**; (1) unossified.

25. Prefrontal into external narial margin **(HPSA 029): (0) distant from**; (1) near; (2) present.

26. External naris in dorsal view **(HPSA 030)**: (0) exposed; (1) not exposed. **Not determinable.**

27. External naris shape **(HPSA 031):** (0) circular; (1) posteriorly extended, along lacrimal-prefrontal suture; (2) posteriorly extended excavation of lacrimal only. **Not determinable.**

28. Dorsal exposure of premaxilla **(HPSA 032)**: **(0) broad pars dorsalis anteromedial to external naris**; (1) pars dorsalis limited, but nasopremaxillary suture exposed dorsally (2) none.

29. Dorsal shape of skull **(HPSA 033): (0) triangular**; (1) diamond; (2) rounded.

30. Posterior skull margin **(HPSA 034):** (0) concave; (1) straight; (2) convex; **(3) undulating**.

31. Snout shape **(HPSA 035)**: **(0) blunt**; (1) pointed.

32. Snout length **(HPSA 036)**: **(0) less than ¼ total skull length**; (1) greater than ¼ total skull length

33. Quadrate articulates along internal flange of squamosal **(HPSA 037):** (0) absent; (1) present. **Not determinable.**

34. Otic/spiracular notch **(HPSA 038)**: **(0) present**; (1) absent.

35. Large otic notch approaching orbit **(HPSA 039)**: (0) more than ½ postorbital length of skull; (1) between ¼ and ½ postorbital length of skull; **(2) less than ¼ postorbital length of skull**.

36. Otic notch structure **(HPSA 040)**: **(0) open posteriorly**; (1) closed posteriorly.

37. Semilunar flange of supratemporal **(HPSA 041): (0) absent;** (1) present.

38. Supratympanic flange **(HPSA 042)**: (0) absent; (1) present.

39. Supratympanic shelf **(HPSA 043):** (0) absent; (1) present.

40. Raised orbital rim **(HPSA 044)**: (0) absent; **(1) present**.

41. Postorbital **(HPSA 045)**: **(0) present**; (1) absent.

42. Jugal-postorbital interfingered processes **(HPSA 046)**: **(0) absent;** (1) present.

43. Postorbital participates in orbital margin **(HPSA 047): (0) present**; (1) absent.

44. Shape of postorbital **(HPSA 048)**: **(0) irregular trapezoid**; (1) triangular, apex caudal.

45. Palpebral ossifications **(HPSA 049): (0) absent;** (1) mosaic of bony plates in orbit (PSAA new state); (2) single large plate above orbit **(new state).**

46. Parietal-tabular contact **(HPSA 052)**: **(0) absent;** (1) present.

47. Postparietals **(HPSA 053)**: **(0) paired**; (1) fused; (2) absent.

48. Parietal foramen **(HPSA 054)**: **(0) present**; (1) absent.

49. Postparietal size **(HPSA 055)**: **(0) much smaller than parietals**; (1) approximately as large or larger than parietals.

50. Postparietal squamosal contact **(HPSA 056)**: **(0) absent;** (1) present.

51. Postparietal length **(HPSA 057)**: **(0) large, quadrangular**; (1) abbreviated anteroposteriorly, elongate lateral rectangle.

52. Squamosal-jugal contact **(HPSA 058)**: **(0) present**; (1) absent.

53. Tabular **(HPSA 059)**: **(0) present**; (1) absent.

54. Posterolateral projection from lateral margin of tabular above squamosal embayment **(HPSA060):** (0) absent; **(1) present.**

55. Tabular horns **(HPSA 061):** (0) absent; **(1) present**.

56. Tabular horns shape **(HPSA 062)**: **(0) parallel or slightly divergent**; (1) widely divergent.

57. Squamosal forms base of tabular horn **(HPSA 063**): **(0) absent;** (1) present.

58. Lateral line canal grooves **(HPSA 064)**: **(0) present**; (1) absent.

59. Dermal sculpturing **(HPSA 065)**: (0) circular pits; (1) shallow ridges and grooves; **(2) little to none**; (3) tuberculate.

60. Premaxilla anterior margin **(HPSA 066)**: **(0) vertical**; (1) overturned.

61. Maxilla into external naris **(HPSA 068)**: **(0) present**; (1) absent.

62. Maxilla entire ventral naris **(HPSA 069)**: **(0) absent;** (1) present.

63. Maxilla **(HPSA 070)**: **(0) longer than palatine**; (1) shorter than palatine.

64. Marginal teeth orientation **(HPSA 071)**: (**0) vertical**; (1) turned medially.

65. Marginal teeth largest anterior **(HPSA 072)**: (0) absent; **(1) present**.

66. Marginal teeth shape **(HPSA 073):** (0) pointed pegs; (1) blunt pegs; **(2) large cones**.

67. Number of premaxillary teeth **(HPSA 074):** (0) 10-20; **(1) 5-9**; (2) <5; (3) 20 or more.

68. Number of maxillary teeth **(HPSA 075)**: (0) 30-40; (**1) 20-29**; (2) 15-19; (3) <15; (4) >40.

69. Teeth laterally compressed **(HPSA 076): (0) no**; (1) yes.

70. Enlarged teeth mid toothrow (maxillary) **(HPSA 077)**: (0) absent; **(1) present**.

71. Teeth **(HPSA 078)**: **(0) simple points**; (1) multiple cusps.

72. Multiple cusp orientation **(HPSA 079)**: (0) labio-lingual; (1) antero-posterior. **Not applicable.**

73. Enamel fluting **(HPSA 080)**: **(0) absent;** (1) present.

74. Labyrinthine infolding **(HPSA 081)**: **(0) present**; (1) absent.

75. Jaw articulation **(HPSA 087)**: **(0) posterior to occiput**; (1) even with occiput; (2) anterior to occiput; (3) far anterior (>20% basal skull length).

76. Internal nares **(HPSA 088)**: **(0) widely separated**; (1) narrowly separated.

77. Lateral exposure of the palatine (LEP) **(HPSA 091): (0) absent;** (1) present.

78. Anterior palatine **(HPSA 092)**: **(0) short anteromedial process articulating with vomer at choana**; (1) long anteromedial process more medial than lateral; (2) palatine absent.

79. Teeth on pterygoid **(HPSA 098)**: (0) absent; **(1) present**.

80. Tooth pedicely **(HPSA 099)**: **(0) absent;** (1) present.

81. Palatal teeth size **(HPSA 103)**: (0) larger than marginal teeth; (1) equal to marginal; (**2) smaller than marginal**.

82. Parasphenoid **(HPSA 104)**: (0) medial of stapes; (1) under footplate of stapes. **Not determinable.**

83. Interpterygoid vacuities **(HPSA 115)**: **(0) narrow or closed**; (1) wide; (2) fused at midline.

84. Anterior extent of pterygoids **(PSAA 84): (0) pterygoids contact anteriorly**; (1) pterygoids exclude vomer from interpterygoid vacuity but excluded from median contact by parasphenoid; (2) pterygoids contact vomer but do not exclude vomer from interpterygoid vacuity; (3) pterygoids reach anteriorly only as far as palatine; (4) pterygoids reach ectopterygoid only; (5) pterygoids do not contact lateral palatal bones at all. (PSAA note: This character serves as a replacement for HPSA 116, 118, and 119)

85. Lateral process of pterygoid into posttemporal fossa **(HPSA 120)**: **(0) absent;** (1) present.

86. Ectopterygoid palatine width **(HPSA 122)**: **(0) wider than maxilla**; (1) narrower than maxilla.

87. Pharyngeobranchial pouches (**HPSA 123**): (0) absent**;** (1) present. **Not determinable.**

88. Dentary (**HPSA 124**): **(0) tooth row greater than 50% of total jaw length**; (1) tooth row less than 50% of total jaw length.

89. Dentary forms coronoid process (**HPSA 125**): **(0) absent;** (1) present.

90. Surangular (**HPSA 126**): **(0) subequal in size to angular**; (1) substantially smaller than angular (2) absent.

91. Angular (**HPSA 127**): (0) approximately as deep as the dentary mid-tooth-row, or less; **(1) deeper than dentary mid-toothrow**.

92. Number of splenials (**HPSA 128**): **(0) 2**; (1) 1; (2) 0.

93. Splenial exposed laterally (**HPSA 129**): **(0) present**; (1) absent.

94. Meckelian fossae (HPSA 130): **(0) 2 or more**; (1) 1; (2) 0.

95. Ventral border of Meckel’s fossa (**HPSA 131**): (0) splenial; (1) angular. **(2) splenial, postsplenial, angular, surangular (BL new state).**

96. Retroarticular process presence (**HPSA 132**): **(0) absent;** (1) present.

97. Retroarticular process shape (**HPSA 133**): (0) straight; (1) hooked. **Not applicable**.

98. Vertical position of jaw articulation relative to tooth row (**HPSA 134**): **(0) above**; (1) equal; (2) below.

99. Extent of angular in lateral view (**HPSA 135**): **(0) posterior tooth row**; (1) middle of tooth row.

100. Number of coronoids (**HPSA 136**): **(0) 3**; (1) 2; (2) 1; (3) 0.

101. Splenial participates in symphysis (**HPSA 139**): **(0) yes**; (1) no.

102. Jaw sculpture (**HPSA 140**): (0) present; **(1) absent**.

103. Ossified hyoids (**HPSA 141**): (0) present; **(1) absent**.

104. Gill osteoderms (**HPSA 142**): **(0) absent;** (1) present noninterdigitating; (2) toothed interdigitating rakers.

105. Parahyoid (**HPSA 143**): **(0) absent;** (1) present.

106. Number of accessory articulations **(HPSA 144)**: (0) 0; (1) 1; **(2) 2 or more**.

107. Number of presacrals **(HPSA 145)**: **(0) 25-35**; (1) 20-24; (2) >35; (3) <20.

108. Vertebral development **(HPSA 146)**: (0) arches then centra; (1) centra and arches simultaneously. **Not determinable**.

109. Caudal processes between depressions **(HPSA 147)**: (0) absent; (1) present.

110. Trunk intercentra **(HPSA 148): (0) present**; (1) absent.

111. Trunk neural arch to centrum in adults **(HPSA 149): (0) loosely articulated**; (1) sutured; (2) fused.

112. Base of neural spine **(HPSA 150)**: (0) equal to or wider than haemal; (1) smaller than haemal spine. **Not determinable**.

113. Height of neural spines **(HPSA 151)**: **(0) even**; (1) alternating.

114. Dermal armor associated with neural arches **(HPSA 152)**: **(0) absent;** (1) present. (PSAA note: “This character was established to recognize the expanded, sculptured structures seen at the top of neural arches in some nectrideans. Upon further examination, this character represents fusion of osteoderms to the neural arch. As this is present in a number of temnospondyls as well as chroniosuchians, we have amended this diagnosis to allow for comparisons outside nectrideans.”)

115. Neural spine shape in lateral view **(HPSA 153): (0) anterior and posterior sides parallel, forming a rectangular surface**; (1) non-parallel, triangular.

116. Neural spine lateral surface **(HPSA 154)**: **(0) smooth**; (1) crenulated.

117. Pleurocentra **(HPSA 155): (0) paired rhachitomous**; (1) closely approaching ventrally; (2) fused dominant weight bearing element; (3) embolomerous. **(4) dorsally fused rhachitomous** (**BL state added**)

118. Haemal arch presence **(HPSA 156)**: **(0) present**; (1) absent.

119. Haemal arch fusion **(HPSA 157)**: **(0) loosely articulated to intercentra**; (1) fused to mid length of centrum.

120. Haemal arch length **(HPSA 158):** (0) longer than or equal to neurals; (1) shorter than neurals. **Not determinable**.

121. Haemal accessory articulations **(HPSA 159):** (0) none; (1) one; (2) two. **Not determinable**.

122. Haemal arch shape **(HPSA 160)**: (0) non parallel triangular; (1) parallel rectangular. **Not determinable**.

123. Tail termination in skeleton **(HPSA 161):** (0) tapers; (1) deep with sudden end. **Not determinable**

124. Tail length **(HPSA 162)**: (0) elongate equal to or exceeding trunk and skull length; (1) foreshortened markedly shorter than trunk. **Not determinable**.

125. Trunk arches **(HPSA 163)**: (0) paired; **(1) fused**.

126. Spinal nerve foramina **(HPSA 164)**: **(0) absent;** (1) present.

127. Extended transverse processes **(HPSA 165): (0) absent;** (1) present.

128. Transverse process **(HPSA 166):** (0) on arch pedicle; (1) on centrum**. Not applicable**

129. Atlas axis intercentra **(HPSA 167): (0) present**; (1) absent.

130. Atlas Anterior centrum **(HPSA 168):** (0) same size as posterior; (1) laterally expanded. **Not determinable**.

131. Atlas centrum **(HPSA 169)**: (0) multipartite; (1) single notochordal; (2) single odontoid. **Not determinable**.

132. Atlas neural arch centrum fusion **(HPSA 170)**: (0) loosely articulated; (1) sutured to centrum; (2) fused to centrum. **Not determinable**.

133. Atlas parapophyses **(HPSA 171)**: (0) on centrum; (1) on transverse process; (2) absent. **Not determinable**.

134. Atlas neural arch midline fusion **(HPSA 172)**: (0) paired; (1) sutured at midline; (2) fused at midline. **Not determinable**.

135. Atlas accessory articulation **(HPSA 173)**: (0) absent; (1) zygosphene; (2) zygantra. **Not determinable**.

136. Proatlantes **(HPSA 174):** (0) present; (1) absent. **Not determinable**.

137. Second cervical arch **(HPSA 175)**: (0) more expanded to subsequent; (1) equal to subsequent; (2) shorter than subsequent. **Not determinable**.

138. Atlas ribs **(HPSA 176)**: (0) one pair; (1) two pairs; (2) absent. **Not determinable**.

139. Cervical rib distal shape **(HPSA 177):** (0) spatulate; **(1) pointed**.

140. Ribs anterior to sacrum **(HPSA 178)**: **(0) short**; (1) long.

141. Ribs **(HPSA 179)**: **(0) elongated and sometimes curved**; (1) straight; (2) short simple rod.

142. Costal process at rib head **(HPSA 180):** (0) absent; (1) present. **Not determinable**

143. Number of sacrals **(HPSA 181)**: **(0) 1**; (1) 2; (2) 3.

144. Sacral parapophysis **(HPSA 182)**: (0) on centrum; (1) on transverse process. **Not determinable**.

145. Number pairs of caudal ribs **(HPSA 183)**: **(0) 5 or more**; (1) 4; (2) 3; (3) 2 or fewer. **Not determinable**.

146. Interclavicle posterior stem length **(HPSA 184):** (0) no or short; **(1) long**.

147. Interclavicle posterior stem breadth **(HPSA 185):** (0) wide; **(1) narrow**.

148. Interclavicle shape **(HPSA 186): (0) diamond shaped**; (1) T-shaped.

149. Interclavicle anterior plate **(HPSA 187)**: **(0) broad**; (1) narrow.

150. Interclavicle shape (if diamond present) **(HPSA 188): (0) broad diamond**; (1) narrow diamond.

151. Interclavicle anterior fimbriation **(HPSA 189)**: **(0) present**; (1) absent.

152. Interclavicle sculpture **(HPSA 190):** (0) present; **(1) absent**.

153. Cleithrum head dorsal extent **(HPSA 191)**: **(0) aligned along anterior rim of scapula**; (1) posterodorsally enlarged head wrapping around dorsal scapula.

154. Cleithrum head size and shape **(HPSA 192): (0) dorsally greatly expanded much wider than shaft**; (1) simple rod without or slight dorsal expansion.

155. Cleithrum ossification **(HPSA 193): (0) ossified**; (1) unossified.

156. Cleithrum overall shape **(HPSA 194)**: **(0) rounded or pointed dorsally**; (1) T or Y shaped.

157. Proximal clavicle blades **(HPSA 195):** (0) widely separate; **(1) articulate medially**; (2) interdigitate.

158. Supraglenoid foramen **(HPSA 196):** (0) present; (1) absent. **Not determinable**

159. Number coracoid foramina **(HPSA 197)**: (0) none; (1) 1; (2) 2. **Not determinable**

160. Scapulocoracoid ossification **(HPSA 198)**: **(0) both**; (1) scapula only; (2) absent.

161. Torsion in humerus **(HPSA 200)**: (0) absent; (1) less than 80 degrees; (2) more than 80 degrees. **Not determinable**.

162. Deltapectoral crest **(HPSA 201)**: (0) weak or absent; (1) intermediate; (2) prominent. **Not determinable**.

163. Supinator process **(HPSA 202)**: **(0) absent;** (1) present.

164. Humerus length **(HPSA 203)**: **(0) long (~4 trunk centra)**; (1) short.

165. Radius-humerus ratio **(HPSA 204)**: (0) > 0.7; (1) 0.5 - 0.7; (2) < 0.5. **Not determinable**.

166. Olecranon process **(HPSA 205):** (0) unossified; **(1) ossified**.

167. Carpals **(HPSA 206)**: **(0) fully or partially ossified**; (1) unossified.

168. Basale commune **(HPSA 207):** (0) absent; (1) present. **Not determinable**.

169. Number digits manus **(HPSA 208)**: **(0) 5**; (1) 4; (2) 3; (3) >5. **Not determinable**.

170. Pelvis **(HPSA 209)**: **(0) fused**; (1) sutured; (2) poorly ossified.

171. Anteriorly inclined ilium **(HPSA 210): (0) absent;** (1) present.

172. Iliac blade **(HPSA 211)**: **(0) 2 dorsal processes**; (1) narrowly bifurcate; (2) single blade.

173. Internal trochanter articulation **(HPSA 212):** (0) distinct; (1) continuous. **Not determinable**.

174. Femoral shaft **(HPSA 213)**: **(0) robust**; (1) slender.

175. Femur **(HPSA 214): (0) long**; (1) short.

176. Tarsals **(HPSA 215):** (0) ossified; (1) unossified. **Not determinable**.

177. Elongate tibiale and fibulare **(HPSA 216)**: (0) absent; (1) present. **Not determinable**.

178. Number of distal tarsals **(HPSA 217):** (0) 6; (1) 5 or fewer. **Not determinable**.

179. Astragalus **(HPSA 218):** (0) absent; (1) present. **Not determinable**.

180. Number of digits pes **(HPSA 219)**: (0) 5; (1) 4 or less; (2) >5. **Not determinable**.

181. Dorsal margin of splenial only contacts first coronoid **(HPSA 220)**: (0) absent; **(1) present**.

182. Postparietal lappet **(HPSA 224)**: (0) mostly exposed posteriorly; (1) equal posteriorly and dorsally; (2) mostlyexposed dorsally. **Not determinable**.

183. Cheek emargination **(HPSA 225)**: **(0) absent;** (1) present.

184. Parietal anterior waisting **(HPSA 226)**: (0) absent; **(1) present**.

185. Parietal width relative to frontal **(HPSA 227)**: **(0) greater**; (1) equal or less.

186. Trabecula cranii **(PSAA 186):** (0) without significant median fusion posterior to solum nasi (platytrabic); (1) fused medially posterior to solum nasi to form elongate trabecula communis (tropitrabic). **Not determinable.**

187. Dorsal trabeculae **(PSAA 187):** (0) dorsal trabeculae provide dorsolateral bridge between sphenoid region and nasal capsule; (1) dorsal trabeculae absent or incomplete, no dorsolateral bridge between sphenoid region and nasal capsule. **Not determinable.**

188. Ossification between optic foramen and pila antotica **(PSAA 188):** (0) ossification complete between optic foramen and pila antotica; (1) pila metoptica and associated cartilaginous taenia unossified. **Not determinable.**

189. Ossification within columella ethmoidalis **(PSAA 189):** (0) absent; (1) present. **Not determinable.**

190. Path of profundus branch of trigeminal nerve **(PSAA 190):** (0) enclosed in lateral wall of sphenoid region of braincase and exits separately from maxillomandibular branch via series of small foramina; (1) extramural, exits antotic fissure with other branches of trigeminal. **Not determinable.**

191. Foramina for optic nerve and trigeminal nerve **(PSAA 191):** (0) confluent; (1) widely separate. **Not determinable.**

192. Lateral head vein **(PSAA 192)**: **(0) no distinct foramen for lateral head vein**; (1) distinct foramen within the antotic fissure serving the lateral head vein.

193. Anterior extent of cultriform process of parasphenoid **(PSAA 193)**: (0) cultriform process extends to anterior margin of sphenethmoid; (1) cultriform process extends far anterior to sphenethmoid; (2) cultriform process does not reach anterior margin of sphenethmoid. **Not determinable.**

194. Olfactory bulbs **(PSAA 194):** (0) narrow; (1) endocasts swollen, leaving considerable impressions in lateral and ventral wall of sphenoid region and in ventral surface of frontal. **Not determinable.**

195. Flange from skull roof articulating with sphenethmoid **(modified from HPSA 223)**: **(0) absent**; (1) present on frontal and parietal; (2) present on frontal only**.**

196. Descending lamina of parietal invades medial orbital wall between 'pleurosphenoid' and 'sphenethmoid' elements **(PSAA 196):** (0) no; (1) yes. **Not determinable.**

197. Foramen for oculomotor nerve **(PSAA 197):** (0) exits braincase far dorsal to foramen for optic nerve; (1) exits braincase at or below optic nerve. **Not determinable.**

198. Intermaxillary fossa **(modified from HPSA 198):** (0) present; (1) absent. **Not determinable.**

199. Intermaxillary fossa **(PSAA 199):** (0) paired; (1) unpaired. **Not determinable.**

200. Sphenethmoid forms interorbital septum **(PSAA 200)**: (0) no; (1) yes. **Not determinable**.

201. Anterior extent of cultriform process along palate **(PSAA 201)**: (0) cultriform process extends anteriorly to level of posterior margin of choana; (1) cultriform process dramatically shortened, barely reaching the level of the posterior margin of the orbit. **Not determinable.**

202. Sutural contact between cultriform process of parasphenoid and vomer **(PSAA 202)**: (0) no; (1) yes. **Not determinable.**

203. Lateral wall of the nasal capsule underplated by lateral processes of the vomer and palatine **(PSAA 203)**: (0) no; (1) yes. **Not determinable.**

204. Cultriform process vaulted high above palatal surface **(PSAA 204)**: (0) no; (1) yes. **Not determinable.**

205. Posterior extent of parasphenoid beneath braincase **(PSAA 205):** (0) floors sphenoid region only; (**1) floors sphenoid and otic region**; (2) floors sphenoid, otic, and occipital regions.

206. Basal tubera **(PSAA 206)**: (0) present, with significant endochondral contribution; **(1) present, with contribution of parasphenoid only**; (2) absent.

207. Path of common internal carotid artery **(PSAA 207)**: (0) does not run alongside braincase, enters braincase directly in region of sella turcica; (1) follows vidian sulcus along posterior surface of basal plate of parasphenoid, enters parasphenoid via vidian canal in basal plate of parasphenoid, divides into cerebral and palatal branches after entering parasphenoid; (2) follows vidian sulcus along posterior surface of basal plate of parasphenoid or lateral wall of braincase, divides into cerebral and palatal branches prior to entering the skull. **Not determinable.**

208. Buccohypophyseal foramen in parasphenoid **(PSAA 208)**: **(0) open**; (1) absent.

209. Morphology of pila antotica **(PSAA 209)**: (0) pila antotica is a thin, broad sheet; **(1) pila antotica is a robust dorsoventral pillar bracing the skull roof against the palate**.

210. Basicranial fissure **(PSAA 210)**: (0) present; (1) absent. **Not determinable.**

211. Location of vidian sulcus **(PSAA 211)**: (0) along ventral surface of braincase; (1) along lateral surface of braincase. **Not determinable.**

212. Basipterygoid joint (**PSAA 212**): (0) epipterygoid comprises entire conus recessus; (1) substantial contribution to conus recessus by pterygoid; (2) conus recessus comprised entirely of pterygoid without epipterygoid participation; (3) pterygoid and parasphenoid broadly sutured without development of a conus recessus. **Not determinable**

213. Hypophyseal fossa **(PSAA 213)**: **(0) single unpaired sulcus**; (1) paired sulci divided medially by ridge originating on dorsum sellae.

214. Bone flanking the dorsum sellae **(PSAA 214)**: (0) concurrent with fully ossified lateral braincase; (1) subparallel with sagittal plane ('pleurosphenoid'); (2) strongly oblique to or perpendicular to sagittal plane ('laterosphenoid'); (3) restricted to dorsum sellae only. **Not determinable**.

215. Basal plate of parasphenoid (**HPSA 105**): (0) roughly quadrangular, basipterygoid articulations narrowly spaced; (1) rectangular laterally, anteroposteriorly narrow, basipterygoid articulations distant. **Not determinable**.

216. Sphenethmoid **(HPSA 114):** (0) ossified; **(1) unossified**.

217. Ossification within the synotic tectum **(PSAA 217)**: (0) synotic tectum massively co-ossified with otic capsules; (1) supraoccipital paired at some point in ontogeny; (2) supraoccipital unpaired throughout ontogeny; **(3) no supraoccipital bone**; synotic tectum invaded by dorsal processes of exoccipitals.

218. Median ascending process of supraoccipital **(PSAA 218):** (0) absent; (1) present. **Not applicable.**

219. Lateral ascending processes of the supraoccipital **(PSAA 219):** (0) absent; (1) present. **Not applicable.**

220. Margin of fenestra vestibuli **(PSAA 220)**: (0) parasphenoid excluded by neurocranial elements (basisphenoid and basioccipital); (1) parasphenoid contributes to anteroventral margin of fenestra vestibuli; (2) parasphenoid floors entire fenestra vestibuli; (3) ossification of otic capsule surrounds entire fenestra vestibuli. **Not determinable.**

221. Crista intervestibularis **(PSAA 221):** (0) crista intervestibularis absent; (1) crista intervestibularis present. **Not determinable.**

222. Morphology of crista parotica **(PSAA 222)**: (0) crista parotica meets exoccipitals only, forming lateral wall of posttemporal fossa but not bracing against dermal skull; (1) crista parotica drawn out dorsolaterally into paroccipital process that contacts the tabular; (2) crista parotica drawn out laterally into paroccipital process that contacts the cheek and/or suspensorium. **Not determinable.**

223. Dorsal process of stapes **(HPSA 111)**: (0) absent; (1) present; **Not determinable**.

224. Facets on dorsal surface of supraoccipital **(PSAA 224)**: (0) absent; (1) present. **Not applicable.**

225. Otoccipital fissure **(PSAA 225):** (0) present; (1) absent. **Not determinable.**

226. Crista parotica **(PSAA 226)**: (0) descends posteriorly; (1) horizontal along the extent of its length. **Not determinable.**

227. Position of quadrate with respect to otic capsules **(PSAA modified from HPSA 82)**: **(0) quadrates ventral and lateral to otic capsules**; (1) quadrates mostly lateral to and greater or equal to twice the width of the otic capsules; (2) quadrates mostly ventral to otic capsules; (3) quadrates approaching or abutting lateral wall of otic capsules.

228. Size of otic capsules **(PSAA 228)**: (0) otic capsules comprise less than 2/3 the width of otoccipital region; (1) otic capsules comprise greater than 2/3 total width of otoccipital region. **Not determinable.**

229. Otic trough **(PSAA 229)**: (0) absent; (1) present. **Not determinable.**

230. Articulation between the epipterygoid and prootic **(PSAA 230):** (0) none; (1) elongate facet on anterior surface of prootic for articulation of epipterygoid. **Not determinable.**

231. Opisthotic obscures occipital in lateral view **(PSAA 231)**: (0) no; (1) yes. **Not determinable.**

232. Fenestra vestibularis at end of broad, wing-like lateral extension of the otic capsule **(PSAA 232):** (0) no; (1) yes. **Not determinable.**

233. Cristae in otoccipital region **(PSAA 233)**: (0) comprised primarily of ascending flanges from braincase; (1) comprised primarily of descending flanges from skull roof. **Not determinable.**

234. Opisthotic excluded from the occipital surface by tabular process of the exoccipital **(PSAA 234)**: (0) no; (1) yes. **Not determinable.**

235. Insertion of epaxial musculature on occiput **(PSAA 235)**: (0) deep within post-temporal fossae; (1) in broad, shallow fossae along occipital surface of postparietals. **Not determinable**.

236. Foramen for internal jugular vein **(PSAA 236)**: (0) between supraoccipital and exoccipital; (1) between opisthotic and exoccipital; (2) through exoccipital; (3) posterior notch of fenestra vestibule. **Not determinable**.

237. Foramina for hypoglossal nerve **(PSAA 237**: (0) multiple; (1) single; (2) none. **Not determinable.**

238. Occipital condyle shape **(PSAA 238 modified from HPSA 085):** (0) round; (1) U-shaped; (2) paired. **Not determinable.**

239. Ventral process of exoccipital reaches basipterygoid joint along palatal surface **(PSAA 239)**: (0) absent; (1) present. **Not determinable.**

240. Occipital condyle shape **(HPSA 84):** (0) concave; (1) convex. **Not determinable.**

241. Columella of stapes **(PSAA modified from HPSA 108): (0) perforate**; (1) imperforate.

242. Orientation of stapes **(PSAA modified from HPSA 109): (0) dorsal, towards tabular or otic notch**; (1) anteroventral, towards quadrate.

243. Stapedial footplate shape **(HPSA 110):** (0) oval; (1) round; (2) palmate. **Not determinable.**

244. Dorsal sinus between synotic tectum and skull roof **(PSAA modified from HPSA 222):** (0) absent; (1) present. **Not determinable.**

245. Ossification within septum internasale **(PSAA 48)**: (0) absent; (1) present, sphenethmoid; (2) present, mesethmoid. **Not applicable.**

246. Ossification of septum internasale invades nasal tectum **(PSAA 49)**: (0) absent; (1) present**. Not applicable.**

247. Insertion of hypaxial musculature **(PSAA 50):** (0) sphenoid; (1) otic; (2) basioccipital. **Not determinable**

248. Prootic supported by pedicel extending from basisphenoid lateral to prootic foramen **(PSAA 51)**: (0) no; (1) yes**. Not determinable.**

249. Position of pineal foramen with respect to hypophyseal foramen **(PSAA 52)**: (0) anterior to; **(1) approximately the same**; (2) far posterior to.

250. Pineal foramen or fossa **(PSAA 53):** (0) well anterior to posterior margin of cerebral fossa; (1) at or behind posterior margin of cerebral fossa**. Not determinable.**

251. Median wall of otic capsule **(PSAA 54)**: (0) completely unossified; (1) ossification of opisthotic; (2) ossification of supraoccipital and basioccipital**. Not determinable.**

252. Conical recess in basioccipital **(PSAA 55):** (0) absent; (1) present**. Not determinable.**

253. Semicircular canals **(PSAA 56)**: (0) separated from utricular region by bone; (1) not separated from utricular region by bone**. Not determinable.**

254. Basioccipital **(PSAA 57)**: **(0) robust ossification ventral to foramen magnum present;** (1) absent.

255. Accessory articulation processes with proatlantal facet on exoccipitals **(PSAA 58):** (0) absent; (1) prominent; **Not determinable.**

256. Exoccipital proatlantal facets incorporated into occipital joint **(PSAA 59):** (0) no; (1) yes**. Not determinable.**

257. Anterior tectal **(modified from CABF 001**): **(0) anterior tectal present**; (1) absent.

258. Ectopterygoid/palatine exposure (**CABF 002): (0) more or less confined to tooth row**; (1) broad medial exposure additional to tooth row; (2) reduced to thin sliver.

259. Ectopterygoid**: (0) present**; (1) absent. **BL note: no attribution given in PSAA.**

260. Ectopterygoid as long or longer than palatines **(CABF 003): (0) yes**; (1) no.

261. Ectopterygoid reaches subtemporal fossa **(CABF 004)**: (0) no; (1) yes. **Not determinable.**

262. Frontal **(CABF 005):** (0) absent**;** **(1) present**.

263. Jugal **(CABF 007)**: (0) does not extend anterior to orbit; (1) extends anterior to orbit. **Not determinable.**

264. Lateral rostral present **(CABF 009)**: (0) yes; **(1) no**.

265. Maxilla makes interdigitating suture with vomer **(CABF 010)**: **(0) no**; (1) yes.

266. Maxilla external contact with premaxilla **(CABF 011)**: **(0) narrow contact point, not interdigitated**; (1) interdigitating suture.

267. Maxilla extends behind level of posterior margin of orbit **(CABF 012)**: **(0) yes**; (1) no.

273. Pterygoid quadrate ramus margin in subtemporal vacuity (**CABF 018**): (0) concave; (1) with some convex component. **Not determinable.**

274. Vomers separated by parasphenoid > half length (**CABF 019**): (0) yes; (1) no. **Not determinable.**

275. Vomers (**CABF 022**): (0) as broad as long or broader; **(1) about twice as long as broad or longer**.

276. Basipterygoid process (**CABF 023**): **(0) not strongly projecting with concave anterior face**; (1) strongly projecting with flat anterior face.

277. Ethmoid (**CABF 024**): (0) fully ossified; (1) partly or wholly unossified. **Not applicable.**

278. Hypophyseal region (**CABF 025**): (0) solid side wall pierced by small foramina for pituitary vein and other vessels; (1) single large foramen. **Not determinable.**

279. Lateral commissure of otic capsule bearing hyomandibular facets (**CABF 026**): (0) present; (1) absent. **Not determinable.**

280. Parasphenoid (**CABF 02**7): **(0) does not overlap basioccipital**; (1) overlaps basioccipital.

281. Denticulate field of parasphenoid (**CABF 028**): **(0) present**; (1) absent.

282. Sphenoid (**CABF 029**): (0) fully ossified, terminating posteriorly in intracranial joint or fused to otoccipital; (1) separated from otoccipital by unossified gap. **Not applicable.**

283. Ectopterygoid fang pairs (**CABF 030**): **(0) present**; (1) absent.

284. Ectopterygoid row (3+) of smaller teeth (**CABF 031**): **(0) present**; (1) absent.

285. Ectopterygoid/palatine shagreen field (**CABF 032**): **(0) absent;** (1) present.

286. Palatine row of smaller teeth (**CABF 034): (0) present**; (1) absent.

287. Pterygoid shagreen (palatine ramus) (**PSAA 287 modified from** **CABF 035**): **(0) dense**; (1) organized radiating rows of denticles; (2) disorganized patches or absent.

288. Dentition of transverse flange of pterygoid (**PSAA 288**): (0) denticle field indistinct from palatine denticle field; (1) distinct raised denticle field; (2) organized tooth row; (3) absent. **Not applicable.**

289. Premaxillary tooth proportions (**CABF 036**): (0) all approximately same size; (1) posteriormost teeth at least twice height of anteriomost teeth; **(2) anteriormost teeth largest.**

290. Vomerine fang pairs (**CABF 037**): **(0) present**; (1) absent.

291. Vomerine fang pairs noticeably smaller than other palatal fang pairs (**CABF 038**): (0) no; **(1) yes**.

292. Vomer anterior wall forming posterior margin of palatal fossa bears tooth row meeting at midline (**CABF 039**): (0) yes; (1) no. **Not applicable.**

293. Vomerine row of teeth (**CABF 040**): **(0) present**; (1) absent.

294. Vomerine shagreen field (**CABF 041**): **(0) absent;** (1) present.

295. Adductor fossa **(CABF 042): (0) faces dorsally**; (1) faces medially.

296. Adductor crest **(CABF 043): (0) absent;** (1) peak anterior to adductor fossa, dorsal margin of fossa concave; (2) peak above anterior part of adductor fossa, dorsal margin of fossa convex.

297. Angular-prearticular contact **(CABF 044)**: (0) prearticular contacts angular edge to edge; **(1) absent;** (2) medial lamina of angular sutures with prearticular.

298. Coronoid (anterior) contacts splenial **(CABF 045):** (0) no; **(1) yes**.

299. Prearticular extends between infradentaries and middle coronoid **(modified from CABF 046): (0) yes**; (1) no.

300. Coronoid (middle) contacts postsplenial **(CABF 047)**: **(0) no**; (1) yes.

301. Coronoid (posterior) posterodorsal process **(CABF 048):** (0) absent; **(1) present.**

302. Coronoid (posterior) posterodorsal process visible in lateral view **(CABF 049):** (0) no; (1) yes. **Not applicable**.

303. Dentary external to angular & surangular, with chamfered ventral edge and no interdigitations **(CABF 050):** (0) no; **(1) yes**.

304. Dentary ventral edge **(CABF 051)**: (0) smooth continuous line; **(1) abruptly tapering or "stepped" margin**.

305. Dentary suture with splenial & postsplenial marked by deep furrow **(CABF 052)**: **(0) no**; (1) yes.

306. Mandibular sensory canal **(CABF 053)**: **(0) present**; (1) absent.

307. Mandibular canal exposure **(CABF 054):** (0) entirely enclosed, opens through lines of pores; **(1) mostly enclosed, short sections of open grooves**; (2) mostly open grooves, short sections opening through pores; (3) entirely open.

308. Oral sulcus/surangular pit line of mandible **(CABF 055): (0) present**; (1) absent.

309. Meckelian bone floors precoronoid sulcus **(CABF 056):** (0) yes; (1) no. **Not applicable**.

310. Meckelian bone ossified in middle part of jaw **(CABF 057): (0) yes**; (1) little or no ossification.

311. Meckelian bone exposure in middle part of jaw **(CABF 058): (0) depth much less than prearticular**; (1) depth similar to prearticular..

312. Meckelian foramina/fenestrae, dorsal margins **(CABF 059)**: **(0) meckelian bone**; (1) prearticular; (2) infradentary.

313. Meckelian foramina/fenestrae height **(CABF 060)**: **(0) much lower than adjacent prearticular**; (1) equal to or greater than depth of adjacent prearticular.

314. Parasymphyseal lateral foramen present **(CABF 061)**: **(0) no**; (1) yes.

315. Parasymphyseal mesial foramen present **(CABF 62): (0) no**; (1) yes.

316. Postsplenial with medial lamina **(CABF 063)**: **(0) no**; (1) small; (2) expanded, contacting precoronoid.

317. Postsplenial pit line present **(CABF 064)**: **(0) yes**; (1) no.

318. Postsplenial suture with prearticular present (**PSAA modified from CABF 065**): (0) no; **(1) yes**.

319. Prearticular sutures with surangular **(CABF 066): (0) no**; (1) yes.

320. Medial lamina of splenial **(PSAA modified from CABF 067**): (0) absent; **(1) present**.

321. Prearticular with longitudinal ridge below coronoids **(CABF 068):** (0) no; **(1) yes**.

322. Prearticular with mesially-projecting flange on dorsal edge along posterior border of adductor fossa **(CABF 069)**: **(0) no**; (1) yes.

323. Prearticular centre of radiation of striations **(CABF 070):** (0) level with posterior end of posterior coronoid; (1) level with middle of adductor fossa; (2) level with posterior end of adductor fossa. **Not Applicable**.

324. Splenial has free ventral flange **(CABF 071)**: **(0) yes**; (1) no.

325. Splenial, rearmost extension of medial lamina **(CABF 072):** (0) closer to anterior end of jaw than to adductor fossa; **(1) equidistant**; (2) closer to anterior margin of adductor fossa than to the anterior end of the jaw.

326. Coronoids; at least one has fang pair recognizable because at least twice the height of coronoid or marginal teeth **(CABF 073):** (0) yes; **(1) no**.

327. Coronoids: at least one has fangs recognizable because noticeable lingual to vertical lamina of bone and to all other teeth **(CABF 074)**: (0) yes; **(1) no.**

328. Coronoids: at least one has organized tooth row **(CABF 075): (0) yes**; (1) no.

329. Coronoids: at least one carries shagreen **(CABF 076)**: **(0) no**; (1) yes.

330. Coronoids: size of teeth (excluding fangs) on anterior and middle coronoids relative to dentary tooth size **(CABF 077)**: (0) about the same; **(1) half the height or less**.

331. Dentary tooth row **(CABF 078): (0) homodont**; (1) markedly heterodont.

332. Dentary with parasymphyseal fangs internal to marginal tooth row **(CABF 079)**: **(0) yes**; (1) no.

333. Dentary teeth **(CABF 080): (0) same size as maxillary teeth**; (1) larger than maxillary teeth; (2) smaller than maxillary teeth

334. Dentary with a row of very small teeth or denticles lateral to tooth row **(CABF 081):** (0) yes; **(1) no**.

335. Parasymphyseal tooth plate **(CABF 082)**: **(0) present**; (1) absent.

336. Parasymphyseal plate dentition **(CABF 083):** (0) shagreen or irregular tooth field; **(1) organized dentition aligned parallel to jaw margin**; (2) no dentition.

337. Parasymphyseal plate has fang pair **(CABF 084)**: (0) no; **(1) yes**.

338. Parasymphyseal plate has tooth row **(CABF 085):** (0) no; **(1) short tooth row, separated from coronoid row by diastema**; (2) long tooth row reaching coronoid.

339. Prearticular shagreen field distribution **(CABF 086)**: (0) gradually decreasing from dorsal to ventral; **(1) well-defined dorsal longitudinal band**; (2) scattered patches or absent.

340. Anterior palatal fenestra **(CABF 087):** (0) single; (1) double; **(2) absent**

342. Interpterygoid vacuities **(CABF 089):** (0) absent; (1) at least 2x wider than long; **(2) 2x longer than wide.**

343. Intracranial joint (**CABF 090**): (0) present in dermal skull roof; **(1) absent in dermal skull roof**.

344. Nature of dermal ornament (**CABF 091**): (0) tuberculate; (1) fairly regular pit and ridge; (2) irregular; **(3) absent or almost absent.**

345. Nature of ornament: starbursts of radiating ornament on at least some bones (**CABF 092**): (0) no; (1) yes. **Not applicable**.

346. Anocleithrum **(CABF 093)**: (0) oblong with distinct anterior overlap area; (1) drop-shaped with no anterior overlap area; **(2) absent**.

347. Cleithrum **(CABF 094)**: (0) ornamented; **(1) not ornamented**.

348. Cleithrum, postbranchial lamina **(CABF 095):** (0) present; **(1) absent**.

349. Autopod **(PSAA modified from CABF 096)**: (0) radials; **(1) digits**.

350. Humerus **(CABF 097):** (0) narrow tapering entepicondyle; **(1) square or parallelogram-shaped entepicondyle**.

351. Ilium, iliac canal **(CABF 098)**: **(0) absent;** (1) present.

352. Ilium, posterior process **(CABF 099):** (0) oriented posterodorsally; **(1) oriented approximately horizontally posteriorly**.

353. Interclavicle **(CABF 100)**: (0) small and concealed or absent; **(1) large and exposed**.

354. Interclavicle shape **(CABF 101)**: (0) ovoid; (1) kite shaped; **(2) with posterior stem**.

355. Lepidotrichia in paired appendages **(CABF 102):** (0) present; **(1) absent**.

356. Posttemporal and supracleithrum **(CABF 103)**: (0) present; **(1) absent**.

357. Radius and ulna **(CABF 104):** (0) radius much longer than ulna; **(1) approximately equal in length**.

358. Ribs, trunk **(CABF 107):** (0) all cylindrical; (1) some or all bear flanges from posterior margin which narrow distally; **(2) some or all flare distally**.

359. Scapular blade **(CABF 108)**: (0) absent**;** (1) small with narrow top; **(2) large with broad top**.

360. Scapulocoracoid **(modified from CABF 109):** (0) small and tripodal; (1) large plate. **Not applicable**.

361. Subscapular fossa **(CABF 110)**: (0) broad and shallow; (1) deeply impressed posteriorly. **Not determinable**.

362. Squamation **(CABF 111)**: (0) complete body covering of scales, all similar; (1) ventral armour of gastralia. **Not applicable**.

363. Pectoral process **(CABF112)**: (0) absent; (1) present; **Not determinable**.

364. Proximal limb of oblique ridge **(CABF 113):** (0) present, separated from anterior margin of humerus by prepectoral space; (1) absent, replaced by deltopectoral crest. **Not determinable**.

365. Latissimus dorsi attachment **(CABF 114)**: (0) diffuse ridged area; **(1) distinct process**.

366. Foramina piercing oblique ventral ridge **(CABF 115)**: (0) many; (1) one moderately large foramen in addition to entepicondylar foramen; **(2) entepicondylar foramen is the only large opening, other foramina are pinpricks or absent**; (3) none.

367. Humerus with well-developed anterior plate **(PSAA 367)**: (0) yes; (1) no. **Not determinable**.

368. Subclavicular ossifications **(PSAA 368)**: **(0) absent;** (1) sometimes present.

369. Radial capitulum **(PSAA 369 modified from Sigurdsen & Green, 2011): (0) approximately same size as ulnar facet**; (1) greatly enlarged and rounded, >2x size of ulnar facet.

370. Lissamphibian inner ear sensu Maddin and Anderson (2012) **(MA 220):** (0) no; (1) yes. **Not determinable**