1 **Position of orbits**: lateral and widely separated (0); dorsal and close

together (1)

2 **Proportion of skull roof** **lying anterior to middle of orbits**: <50% (0); ≧50% (1)

3 **Facial lamina of premaxilla**: vertical, indicating deep snout (0); curved

posteriorly, indicating flattened snout (1)

4 **Facial lamina of premaxilla**: height less than 50% of length of premaxilla (0);

more than 50% of length of premaxilla (1)

5 **Orientation of anterior tectal and lateral rostral relative to anterior nostril**: dorsal/ventral (0); posterior/anterior (1)

6 **Postrostral**: absent (0); postrostral mosaic of small variable bones (1); large median postrostral, with or without accessory bones (2)

7 **Number of nasals**: more than two (0); two (1); one (2)

8 **Position of anterior nostril**: facial (0); edge of mouth (1)

9 **Dermintermedial process**: absent (0); present (1)

10 **Position of posterior nostril**: external, far from jaw margin (0); external, close to jaw margin (1); palatal (2)

11 **Number of supraorbitals**: one (0); more than one (1)

12 **Posterior or posteriormost supraorbital (postfrontal) extends anterior of orbit**: yes (0); no (1)

13 **Relative size of anterior (or anteriormost) supraorbital (prefrontal, posterior**

**tectal of Jarvik) and posterior (or posteriormost) supraorbital (postfrontal)**: similar (0); anterior supraorbital much bigger (1)

14 **Shape of posterior supraorbital**: posterior process similar in length or shorter than orbital margin (0); posterior process much longer than orbital margin (1)

15 **Contact between parietal and supraorbital**: present (0); absent (1)

16 **Intertemporal**: present (0); absent (1)

17 **Contact between posterior supraorbital and intertemporal**: present (0); absent (1)

18 **Number of tectals**: one (0); more than one (1)

19 **Paired frontal bones meeting in midline, anterior to parietals**: absent (0); present (1)

20 **Width of ethmoid relative to length from snout tip to posterior margin of**

**parietals**: more than 80% (0); 70 – 79% (1); 50 – 69% (2); less than 50% (3)

21 **Pineal foramen**: present (0); absent (1)

22 **Shape of pineal series:** round or oval (0); kite shaped with distinct posterior corner (1)

23 **Location of pineal foramen/eminence**: level with, or anterior to posterior margin of orbits (0); posterior to orbits (1)

24 **Parietals surround pineal foramen/eminence**: yes (0); no (1)

25 **Dermal intracranial joint**: absent (0); present (1)

26 **Postparietals narrow to a point posteriorly**: no (0), yes (1)

27 **Proportions of postparietal shield maximum width of postparietal shield versus**

**skull width at level of anterior end of postparietal**: maximum width of postparietal shield <1/3 skull width at level of anterior end of postparietal (0); maximum width of postparietal shield >=1/3 skull width at level of anterior end of postparietal (1)

28 **Spiracular notch**: small hole or narrow slit (0); wide notch between skull roof and cheek (1)

29 **Extratemporal**: absent (0); present (1)

30 **Contact between extratemporal and supratemporal**: absent (0); present (1)

31 **Extrascapulars**: present (0); absent (1)

32 **Anterior margin of median extrascapular**: long (0); very short (1)

33 **Median extrascapular overlap**: median extrascapular overlapped by lateral extrascapulars (0); median extrascapular overlapping lateral extrascapulars

(1)

34 **Internasal pits**: undifferentiated or anterior palatal fossa (0); shallow paired pits with strong midline ridge (1); deep pear-shaped pits (2)

35 **Tectum orbitale**: narrow (0); extensive (1)

36 **Large median opening and several small dorsolateral openings in postnasal**

**wall**: absent (0); present (1)

37 **Position of exit of pituitary vein**: in front of basipterygoid process (0);

dorsal to vertical portion of basipterygoid process (1)

38 **Descending process of sphenoid**: absent (0); present (1)

39 **Endoskeletal intracranial joint**: absent (0); present (1)

40 **Proportion of neurocranium**: ethmosphenoid shorter than or equal in length

to otoccipital (0); ethmosphenoid longer than otoccipital (1)

41 **Dorsal element of hyoid arch**: hyomandibula articulating with lateral

commissure (0); stapes inserted into fenestra ovalis (1)

42 **Relative positions of hyomandibular facets**: ventral anterior to dorsal (0);

dorsal directly above ventral (1); dorsal anterior to ventral (2)

43 **Vestibular fontanelle**: absent (0); present (1)

44 **Anterior margin of vestibular fontanelle anterior to posterior margin of**

**basicranial fenestra**: no (0); yes (1)

45 **Basicranial fenestra**: absent (0); present (1)

46 **Posttemporal fossae**: absent (0); present (1)

47 **Extent of crista parotica**: does not reach posterior margin of tabular

(0); reaches posterior margin of tabular (1)

48 **Otical process**: absent (0); present (1)

49 **Foramina** (similar to infradentary foramina) **on cheek bones**: absent (0); present (1)

50 **Postorbital**: contributes to orbital margin (0); excluded from orbital margin (1)

51 **Jugal extends anterior to middle of orbit:** no (0); yes (1)

52 **Relationship of jugal to orbit**: contributes to orbital margin (0); excluded

from orbital margin (1)

53 **Lacrimal excluded from orbit**: no (0); yes (1)

54 **Contact between posterior supraorbital (postfrontal) and lacrimal**: absent (0); present (1)

55 **Jugal-quadratojugal contact**: absent (0); present (1)

56 **Number of cheek bones bearing preopercular canal posterior to jugal**: one

(0); two (1)

57 **Bone bearing both quadratojugal pit-line and preopercular canal**: absent

(0); present (1)

58 **Bar-like preopercular**: absent (0); present (1)

59 **Subsquamosals**: absent (0); present (1)

60 **Preoperculosubmandibular**: absent (0); present (1)

61 **Vomer proportions**: not much broader than long (0); much broader than long (1)

62 **Anteromedial process of vomer**: absent (0); present (1)

63 **Posterior process of vomers**: absent (0); short (1); long (2)

64 **Articulation of vomers**: vomers not articulating with each other (0); vomers

articulating with each other (1)

65 **Parasphenoid**: protruding forward into ethmoid region of endocranium (0); behind ethmoid region (1)

66 **Denticulated field of parasphenoid**: without spiracular groove (0); with spiracular groove (1)

67 **Relationship of vomer to parasphenoid**: no contact, or simple abutment (0); dorsal/ventral overlap anteriorly (1); side to side overlap between posterior processes of vomers and lateral sides of parasphenoid (2)

68 **Shape of parasphenoid**: broad, splint-shaped (0); slender, splint-shaped (1)

69 **Lateral sides of parasphenoid**: parallel or slightly diverging anteriorly (0);

converging anteriorly (1)

70 **Posterior carotid opening in parasphenoid:** present (0); absent (1)

71 **Articulation of pterygoids**: pterygoids not articulating with each other (0); pterygoids articulating with each other (1)

72 **Proportions of entopterygoid**: anterior end level with processus ascendens (0); anterior end considerably anterior to processus ascendens (1)

73 **Number of fang pairs on ectopterygoid**: two (0); one (1); none (2)

74 **Palatal fangs mesial to marginal tooth row**: yes (0); no (1)

75 **Subterminal mouth**: absent (0); present (1)

76 **Enlarged anterior tooth on premaxilla**: absent (0); present (1)

77 **Posterodorsal process of maxilla**: present (0); very weak or absent (1)

78 **Meckelian ossification**: strong, complete from articular to symphysial region (0); incomplete (1); absent (2)

79 **Coronoids labiolingually flattened**: no (0); yes (1)

80 **Protrusion of lower jaw in front of skull**: absent (0); present (1)

81 **Anteroventral lower jaw profile**: rounded (0); squared off (1)

82 **Large ventromesially directed flange of symphysial region of mandible**:

absent (0); present (1)

83 **Dermal ornament on each infradentary**: even (0); separate “starburst” on

each bone (1)

84 **Infradentary foramina**: always present (0); variable (1); always absent (2)

85 **Dentary fang pair**: absent (0); present (1)

86 **Teeth of dentary**: reaching anterior end of dentary (0); not reaching

anterior end (1)

87 **Accessory tooth rows on dentary**: present (0); absent (1)

88 **Splenial**: not sutured to prearticular (0); sutured to prearticular (1); postsplenial obstructing splenial-prearticular contact (2)

89 **Suture between splenial and anterior coronoid**: absent (0); present (1)

90 **Mesial lamina of splenial**: absent (0); present (1)

91 **Angular and prearticular**: separated by ventral exposure of Meckelian bone (0); in contact (1)

92 **Parasymphysial tooth whorl**: present (0); absent (1)

93 **Parasymphysial dental plate**: absent (0); present (1)

94 **Parasymphysial dental plate**: long with posterior corner, sutured to anterior coronoid, denticulated or with tooth row (0); short, rounded, not sutured to anterior coronoid, denticulated (1)

95 **Tooth row on parasymphysial dental plate**: absent (0); present (1)

96 **Mesial parasymphysial foramen**: absent (0); present (1)

97 **Fangs of coronoids** (*sensu stricto*): absent (0); present (1)

98 **Marginal denticle band on coronoids**: broad band, at least posteriorly (0); narrow band with 2-4 denticle rows (1); single tooth row or absent (2)

99 **Coronoid proportions**: posterior coronoid similar in length to, or shorter than middle coronoid (0); posterior coronoid significantly longer than middle coronoid (1)

100 **Number of fang pairs on posterior coronoid**: two (0); one (1); none (2)

101 **Anterior end of prearticular**: not forked (0); forked (1)

102 **Longitudinal dorsal ridge on prearticular**: absent (0); present (1)

103 **Anterior mandibular (precoronoid) fossa**: absent (0); present (1)

104 **Retroarticular process**: absent (0); present (1)

105 **Foramen in hyomandibular**: absent (0); present (1)

106 **Opercular process of hyomandibula**: present (0); absent (1)

107 **Distal portion of hyomandibula**: developed (0); reduced (1); absent (2)

108 **Contact between hyomandibula and palatoquadrate**: present (0); absent (1)

109 **Position of distal exit of hyomandibular canal or sulcus on anterolateral face of**

**hyomandibula**: at a level of mid-shaft or obvious curvature (0); within proximal portion (1)

110 **‘Urohyal’ morphology**: dorsoventrally compressed and rod-like, may

bifurcate posteriorly (0); vertical plate (1)

111 **Shape of anterior basibranchial**: rounded (0); rectangular, significantly longer than wide (1)

112 **Sublingual rod**: absent (0); present (1)

113 **Opercular**: present (0); absent (1)

114 **Number of branchiostegal rays per side**: more than one (0); one (1)

115 **Size of median gular**: small (0); large (1)

116 **Course of ethmoid commissure**: canal penetrating the body of the premaxilla (0); sutural course (1)

117 **Direction of anterior pit-line on parietal shield**: antero-posterior, reaching

or almost reaching parietal-postparietal border (0); essentially transverse, anterior or

almost anterior to pineal foramen/eminence (1)

118 **Middle and posterior pit-lines on postparietal**: posteriorly situated (0);

mesially situated (1)

119 **Course of supraorbital canal**: straight (0); lyre-shaped (1)

120 **Posterior end of supraorbital canal**: in postparietal (0); in parietal (1); in

intertemporal (2)

121 **Contact between otic and supraorbital canals**: not in contact (0); in contact

(1)

122 **Otic (postotic) canal**: runs through skull roof (0); follows edge of skull

roof (1)

123 **Otic (postotic) canal enters postparietal**: no (0); yes (1)

124 **Supracleithrum and posttemporal**: present (0); absent (1)

125 **Curvature of dermal shoulder girdle**: smoothly curving chain from cleithrum

to posttemporal, paralleling the posterior margin of the skull (0); tall caudally-inclined

cleithrum sloping away from the skull and forming sharp angle with anocleithrumsupracleithrum-posttemporal (if present) (1)

126 **Cleithral ornamentation**: present (0); absent (1)

127 **Contact margin for clavicle on cleithrum**: straight or faintly convex (0); strongly concave (1)

128 **Ventral or lower lamina of cleithrum**: extensive without or with little

scapulocoracoid lateral exposure (0); reduced, with large scapulocoracoid lateral

exposure (1)

129 **Overlap relations of cleithrum and clavicle**: normal (0); rhizodontid

condition (1)

130 **Depressed posterior flange on cleithrum**: absent (0); poorly developed (1); well developed (2)

131 **Narrow waist on cleithrum**: no (0); yes (1)

132 **Ventral lamina of cleithrum much broader than dorsal lamina**: no (0); yes

(1)

133 **Clavicle ascending process**: clavicle has rod-like ascending process (0);

clavicle lacks rod-like ascending process (1)

134 **Interclavicle size**: small (0); large (1)

135 **Scapulocoracoid and cleithrum attachment**: triradiate scapulocoracoid lying flush against internal surface of cleithrum, not separated by foramina (0); single large foramen piercing C-shaped scapulocoracoid close to contact face for cleithrum (1); scapulocoracoid attaching to cleithrum via three buttresses (2); scapulocoracoid attaching to cleithrum along its anterodorsal margin (3)

136 **Scapular process of scapulocoracoid**: small (0); large, dorsally projecting (1)

137 **Subscapular fossa**: absent (0); present (1)

138 **Coracoid plate**: absent (0); present and extends ventromedially (1)

139 **Pectoral fin radials**: only preaxial and terminal (0); preaxial and postaxial radials in distal part of fin, only preaxial radials in proximal part (1); symmetrical array of preaxial and postaxial radials (2)

140 **Shape of ectepicondyle**: rounded (0); elongate parallel-sided ridge (1)

141 **Entepicondyle size**: entepicondyle narrow relative to humerus shaft length (0); entepicondyle as broad as or broader than humerus is long (1)

142 **Body of humerus**: cylindrical (0); flattened rectangular (1)

143 **Caput humeri**: almost flat (0); ball-shaped (1); elongate (2)

144 **Area proximal to radial facet**: short, cylindrical leading edge (0); enlarged, sharp leading edge (1)

145 **Shape of entepicondyle**: narrow, finger-like (0); broad rectangular plate (1)

146 **Discrete pectoral process on ventral ridge of humerus**: absent (0);

present (1)

147 **Postaxial process on ulnare**: present (0); absent (1)

148 **Pectoral fin radials**: jointed (0); unjointed (1)

149 **Radial length**: longer than humerus (0); equal to or shorter than humerus (1)

150 **Shape of radius**: bladelike (0); subcylindrical (1)

151 **Termination of radius**: radius and intermedium terminate at different levels

(0); radius and intermedium terminate at same level (1)

152 **Digits:** absent (0); present (1)

153 **Dorsal and anal fins**: present (0); absent (1)

154 **Caudal fin**: heterocercal (0); triphycercal (1); diphycercal (2)

155 **Epichordal radials in caudal fin**: absent (0); present (1)

156 **Well-ossified ribs**: absent (0); present (1)

157 **Expanded ribs**: absent (0); present (1)

158 **Imbricate ribs**: absent (0); present (1)

159 **Sacrum**: absent (0); present (1)

160 **Intercentra fused to solid ring**: no (0); yes (1)

161 **Ossified supraoccipital plug for the attachment of the supraneural ligament**: present (0); absent (1)

162 **Scales**: rhombic (0); intermediate between rhombic and round (1); round (2)

163 **Median boss on round scale**: present (0); absent (1)

164 **Long basal segments of lepidotrichia in pectoral fin**: no (0); yes (1)

165 **Basal scutes associated with fins**: absent (0); present (1)

166 **Pore-canal network**: absent (0); present (1)

167 **Enamel lining of pore canals**: absent (0); present (1)

168 **Rostral tubuli**: absent (0); present (1)

169 **Plicidentine**: absent (0); simple or generalized polyplocodont (1); labyrinthodont (2); dendrodont (3)

170 **Postspiracular**: absent (0); present (1)

171 **Posterior carotid opening in parasphenoid**: large (0); small (1)

172 **Interclavicle ornamentation**: unornamented (0); ornamented (1)

173 **Choana**: absent (0); present (1)

174 **Anocleithrum**: exposed (0); subdermal (1)

175 **Archipterygial pectoral fin**: no (0); yes (1)

176 **Submandibulars**: present (0); absent (1)

177 **Gular**: present (0); absent (1)

178 **Contact between postorbital and lacrimal**: absent (0); present (1)

179 **Contact between postfrontal and supratemporal**: no (0); yes (1)

180 **Transverse joint at the level of the ulnare, intermedium and radius**:

absent (0); present (1)

181 **Branched radials distal to the ulnare**: absent (0); present (1)

182 **Olecranon process on ulna**: absent (0); present (1)

183 **Radial facet** : faces distally (0); has some ventrally directed component

(1)

184 **Ulnar facet**: faces distally (0); has some ventrally directed component

(1)

185 **Glenoid position**: elevated from plane formed by clavicles (0); offset

ventrally to lie at same level as clavicular plane (1)

186 **Glenoid orientation**: posterior orientation (0); lateral component to

glenoid orientation (1)

187 **Premaxillary tooth proportion**: all approximately same size

(0); enlarged anterior tooth (1); posteriormost teeth at least twice height of

anteriormost teeth (2)

188 **Anocleithrum**: oblong with distinct anterior overlap area (0); dropshaped

with no anterior overlap area (1); absent (2)

189 **Glenoid proportions**: height/width ratio 60% or greater (0); height/width ratio

40-50% 1)

190 **Interclavicle shape**: ovoid (0); kite-shaped (1); kite-shaped with

posterior stalk (2)

191 **Deltoid and supinator process on humerus**: absent (0); present (1)

192 **Anterior termination of ventral ridge**: adjacent to the caput humeri (0); offset

distally toward the proximodistal mid-region of anterior margin of humerus (1)

193 **Radius and ulna**: radius much longer than ulna (0); approximately

equal length (1)

194 **Lepidotrichia in paired appendages**: present (0); absent (1)

195 **Ribs, trunk**: no longer than diameter of intercentrum (0); longer (1)

196 **Ribs, trunk:** all cylindrical (0); some or all bear flanges from posterior margin that narrow distally (1); some or all flare distally (2)

197 **Supraneural spines**: present (0); absent (1)

198 **Number of transverse flexion distal to ulnare**: 1-2 rows (0); 3 rows (1); 4

rows (2); 5-6 rows (3)

199 **Number radials articulating on ulnare**: 0-2 radials (0); 3-4 radials (1); 5 radials (2)

200 **Number of digits**: five or less (0); more than five (1)

201 **Radiale**: absent (0); small (approximately one fifth the length of the radius) (1); large

(approximately half the length of the radius) (2)

202 **Tabular horn**. A tabular horn is formed by an embayment in the posterior margin of

the tabular: absent (0); present (1)