

Appendix 3

Character list used in the phylogenetic analyses:

- (1) Tubules of subpleural components of hyomandibular lateral line canals: (0) not branched at extremities; (1) extremities dichotomously branched. From Carvalho *et al.* (2004).
- (2) Subpleural components of the hyomandibular lateral line canals: (0) posterior branch extends caudally more or less parallel to longitudinal body axis; (1) posterior branch in flexes towards midline to form a lateral hook; (2) posterior branch inflects to continue anteriorly almost parallel to anterior branch, forming a large indentation. From Carvalho *et al.* (2004).
- (3) Suborbital components of infraorbital lateral line canals: (0) projecting posteriorly lateral to mouth; (1) projecting posteriorly lateral to mouth and anteriorly lateral to nasal openings; (2) forming a complex web-like pattern on lateral aspects of the anteroventral disc region. From Carvalho *et al.* (2004).
- (4) Scapular loops formed by scapular components of trunk lateral line canals: (0) absence of loops; (1) presence of scapular loops. From Carvalho *et al.* (2004).
- (5) Anterior process of neurocranium: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (6) Preorbital process: (0) present; (1) absent. From Carvalho *et al.* (2004).
- (7) Preorbital canal for passage of superficial ophthalmic nerve: (0) dorsally located; (1) anteriorly located. From Carvalho *et al.* (2004).
- (8) Foramen for the optic (II) nerve: (0) moderately sized; (1) very enlarged. From Carvalho *et al.* (2004).
- (9) Postorbital process of neurocranium: (0) infraorbital lateral line canal separates postorbital process from small, anterior triangular outgrowth (supraorbital process) of the supraorbital crest; (1) postorbital process with small foramen for passage of infraorbital lateral line canal. From Carvalho *et al.* (2004).
- (10) Extent of orbital region: (0) orbital region of neurocranium long; (1) shortened orbital region with more anteriorly placed supraorbital and postorbital process. From Carvalho *et al.* (2004).
- (11) Postorbital process: (0) without ventrolateral projection; (1) continuing ventrolaterally to form a cylindrical projection. From Carvalho *et al.* (2004).
- (12) Ventrolateral expansion of nasal capsules: (0) nasal capsules laterally expanded; (1) nasal capsules ventrolaterally expanded. From Carvalho *et al.* (2004).
- (13) Articulation between hyomandibula and Meckel's cartilage: (0) hyomandibulae directly attached to lower jaws; (1) hyomandibulae articulating with lower jaws through strong, stout ligament (hyomandibular-Meckelian ligament) at distal tip. From Carvalho *et al.* (2004).
- (14) Angular cartilages: (0) absence of angular cartilages within hyomandibular-Meckelian ligament; (1) presence of angular cartilages within ligament. From Carvalho *et al.* (2004).
- (15) Secondary hyomandibular cartilages: (0) absent; (1) present. From Carvalho *et al.* (2004).

- (16) Symphyseal fusion of upper and lower jaws: (0) antimeres separate at symphysis; (1) both antimeres of jaws symphyseally fused. From Carvalho *et al.* (2004).
- (17) Mandibular width at symphysis: (0) lower jaws slender at symphysis; (1) lower jaws symphyseally thickened. From Carvalho *et al.* (2004).
- (18) Lateral projections of lower jaws: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (19) Basihyal cartilage: (0) basihyal laterally elongated, fused to first hypobranchialis; (1) basihyal a single element, but separate from first hypobranchials; (2) basihyal separate from first hypobranchials but fragmented into more than one component; (3) basihyal absent. From Carvalho *et al.* (2004).
- (20) Fusion of ventral pseudohyoid and first ceratobranchial: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (21) Arrangement of posterior ceratobranchials: (0) separate from each other; (1) ankylosis between fourth and fifth ceratobranchials; (2) fourth and fifth ceratobranchials fused to each other. From Carvalho *et al.* (2004).
- (22) Median projection of the basibranchial medial plate: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (23) Articulation between fifth epi- and ceratobranchial elements to scapulocoracoid: (0) close together; (1) widely separated. From Carvalho *et al.* (2004).
- (24) Lateral stay of synarcual: (0) originates ventral to spinal nerve foramina; (1) originates dorsal to spinal nerve foramina; (2) contacting synarcual both dorsally and ventrally to foramina. From Carvalho *et al.* (2004).
- (25) Fossa on dorsal scapular region: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (26) Contact between pro- and mesopterygium in the pectoral fin: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (27) Distinct components of the mesopterygium: (0) mesopterygium single element; (1) fragmented; (2) missing altogether. From Carvalho *et al.* (2004).
- (28) Lateral expansion of radials in pectoral region: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (29) External margin of mesopterygium: (0) more or less straight, not fused to radials; (1) undulated, not fused to radials; (2) highly sinuous, appearing to be fused with articulating radial elements. From Carvalho *et al.* (2004).
- (30) Median prepelvic process: (0) absent or weakly developed; (1) very elongated. From Carvalho *et al.* (2004).
- (31) Pelvic girdle shape: (0) not arched or only moderately so; (1) greatly arched. From Carvalho *et al.* (2004).
- (32) Dorsal fin: (0) present; (1) absent. From Carvalho *et al.* (2004).
- (33) Cartilaginous rod in tail: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (34) Caudal fin: (0) present; (1) reduced to tail-folds; (2) absent. From Carvalho *et al.* (2004).

- (35) Adductor mandibulae complex: (0) without posteromedial extension; (1) posteromedial extension present. From Carvalho *et al.* (2004).
- (36) Spiracularis muscle: (0) projecting ventrally to insert on either palatoquadrate, Meckel's cartilage, and/or hyomandibula; (1) projecting ventrally and posteriorly beyond hyomandibulae and both sets of jaws to insert dorsal to coracomandibularis; (2) projecting ventrally and posteriorly beyond hyomandibulae and both sets of jaws to insert ventral to coracomandibularis. From Carvalho *et al.* (2004).
- (37) Depressor mandibularis muscle: (0) present; (1) absent. From Carvalho *et al.* (2004).
- (38) Coracohyoideus muscle: (0) not connected at midline; (1) connected at midline. From Carvalho *et al.* (2004).
- (39) Urea retention: (0) urea retained in blood; (1) urea excreted in urine. From Carvalho *et al.* (2004).
- (40) Rectal gland: (0) present; (1) reduced. From Carvalho *et al.* (2004).
- (41) Spiracular tentacle: (0) absent; (1) present. From Carvalho *et al.* (2004).
- (42) Cephalic lobes: (0) absent; (1) single and continuous; (2) single with an indentation; (3) paired. From Carvalho *et al.* (2004).
- (43) Nasal curtain: (0) not reaching mouth region; (1) extending posteriorly as far as mouth opening. From Carvalho *et al.* (2004).
- (44) Tooth type in both upper and lower jaws: (0) minute; (1) broad. From Claeson *et al.* (2010).
- (45) Arrangement of teeth in both upper and lower jaws: (0) arranged in separate diagonal rows or ribbons; (1) horizontal conveyor or pavement-like arrangement. From Claeson *et al.* (2010).
- (46) Tooth shape: (0) square to rounded; (1) hexagonal, six distinct sides; (2) rectangular with posteriorly deflected lateral margins. From Claeson *et al.* (2010).
- (47) Lateral teeth: (0) present; (1) absent. From Claeson *et al.* (2010).
- (48) Differentiation of median teeth from lateral teeth: (0) median and lateral teeth are similar; (1) median teeth relatively expanded. From Claeson *et al.* (2010).
- (49) Differentiation among lateral teeth: (0) lateral teeth unexpanded; (1) some lateral teeth expanded. From Claeson *et al.* (2010).
- (50) Relative amount of curvature in expanded lower teeth: (0) straight and uncurved; (1) moderately curved; (2) strongly curved. From Claeson *et al.* (2010).
- (51) Upper tooth curvature: (0) uncurved; (1) curved. From Claeson *et al.* (2010).
- (52) Direction of tooth curvature: (0) concave; (1) flat; (2) convex; (3) sigmoidal. Modified from Claeson *et al.* (2010). State 3 is newly proposed.
- (53) Tooth association: (0) loosely interlocking; (1) sometimes loosely interlocking or tightly interlocking; (2) tightly interlocking. From Claeson *et al.* (2010).
- (54) Tooth interlocking mechanism: (0) overlapping; (1) tongue and groove; (2) no direct contact. From Claeson *et al.* (2010).

- (55) Shape of interlocking tongue: (0) bulbous; (1) short shelf; (2) long shelf. From Claeson *et al.* (2010).
- (56) Crown height: (0) crown height exceeds root depth on unworn teeth; (1) low crown. From Claeson *et al.* (2010).
- (57) Occlusal surface: (0) cusped; (1) smooth; (2) depressed. From Claeson *et al.* (2010).
- (58) Crown shape in anterior or posterior view: (0) straight; (1) domed; (2) deep. From Claeson *et al.* (2010).
- (59) Lateral margins: (0) not pinched; (1) pinched. From Claeson *et al.* (2010).
- (60) Root type: (0) holaulacorhizous; (1) polyaulacorhizous. From Claeson *et al.* (2010).
- (61) Number of roots: (0) 2 roots; (1) 3 to 4 roots; (2) 5 roots or greater. From Claeson *et al.* (2010).
- (62) Roots in basal view: (0) triangles; (1) wide blocks; (2) narrow blocks; (3) fine edges. From Claeson *et al.* (2010).
- (63) Distance between roots: (0) broad, groove wider than root; (1) narrow. From Claeson *et al.* (2010).
- (64) Inclination of roots: (0) no inclination; (1) offset and step-like; (2) long and strongly inclined. From Claeson *et al.* (2010).
- (65) Root groove position: (0) regularly spaced between laminae; (1) irregularly spaced between laminae. From Claeson *et al.* (2010).
- (66) Ornamentation of the occlusal surface: (0) smooth; (1) polygonal pits; (2) granular ornamentation; (3) sinuous vermiculae.
- (67) Ornamentation of the lingual bulge: smooth (0); bearing vertical folds (1).
- (68) Root blocks shape (in basal view): blocks extending from labial to lingual edges of the root (0); do not cross root longitudinally (1).
- (69) Tooth absence: teeth present in both jaws (0); teeth absent in upper jaw (1). From Underwood *et al.* (2017).
- (70) Sexual heterodonty: teeth of males and females the same (0); teeth of males more cuspidate (1). From Underwood *et al.* (2017).
- (71) Vertical ridges on sides of teeth: absent (0); present (1). From Underwood *et al.* (2017).
- (72) Suturing between occlusal surfaces of teeth: absent (0); occlusal joint sutured (1). From Underwood *et al.* (2017).
- (73) Lateral projections of lower jaws: absent (0); unfused (0); fused (2). From Underwood *et al.* (2017).
- (74) Mandibular symphyses: unfused (0); fused, tessellated partition present (1). From Underwood *et al.* (2017).
- (75) Thickening of cartilage around mandibular symphyses: absent (0); present (1). From Underwood *et al.* (2017).
- (76) Adductor mandibulae major inserting via tendon directly into palatoquadrate: absent (0); present (1). From Underwood *et al.* (2017).
- (77) Lateral processes of the palatoquadrate extending far anteriorly: absent (0); present (1). From Underwood *et al.* (2017).

- (78) Anterior processes of the Meckel's cartilage: absent (0); present (1); extending anterior past jaw joint (2). From Underwood *et al.* (2017).
- (79) Oral gape wider than lower tooth module length: equal (0); gape width smaller (1); gape width larger (2). From Underwood *et al.* (2017).
- (80) Lateral oral diastema alt: diastema width greater than occlusal width (0); occlusal width greater than diastema width (1). From Underwood *et al.* (2017).
- (81) Upper jaw profile: oval in cross-section (0); flat top, convex occlusal surface (1); strongly flattened (2). From Underwood *et al.* (2017).
- (82) Upper jaw mineralization: all surfaces mineralized (0); lingual face partly unmineralized (1). From Underwood *et al.* (2017).
- (83) Lower jaw profile: oval in cross-section (0); strongly linguolabially expanded (1). From Underwood *et al.* (2017).
- (84) Upper jaw trabeculae: absent (0); weakly developed (1); strongly developed (2). From Underwood *et al.* (2017).
- (85) Lower jaw trabeculae: absent (0); weakly developed (1); strongly developed (2). From Underwood *et al.* (2017).
- (86) Lower jaw full of granular tesserae: absent (0); present (1). From Underwood *et al.* (2017).