

APPENDIX 1

List of characters and character states used in the phylogenetic analysis.

Mandibular and dental characters

- (1) Prementary, denticle shape: spike-like (0); triangular with rounded edges (1). (Adapted from Horner et al., 2004, character 13).
- (2) Prementary, denticle spacing: wider than base of each individual denticle (0); narrower than or as wide as base of each denticle (1).
- (3) Prementary, orientation of rostral surface: subvertical (0); facing rostroventrally (1). (Adapted from Horner et al., 2004, character 14).
- (4) Prementary proportions: length of lateral process larger or subequal than mediolateral width of rostral margin of prementary (0); length of lateral process less than (but larger than half) mediolateral width of rostral margin of prementary (1); length of lateral process less than half mediolateral width of rostral margin of prementary (2).
- (5) Prementary, overall profile in dorsal or ventral view: crescentic, with rounded anterolateral corners (0); subrectangular or subsquared, i.e., anterolateral corners less rounded and more orthogonal (1). (Adapted from Horner et al., 2004, character 13).
- (6) Dentary, caudal extent of tooth row relative to coronoid process: tooth row terminates flush with or rostral edge of coronoid process (0); tooth row terminates ventral to apex of coronoid process (1); tooth row terminates caudal to apex of coronoid process (2). (Adapted from Hai-Lu You et al., 2003, character 29).
- (7) Dentary, inclination of coronoid process: slightly inclined caudally (0); subvertical (1); rostrally inclined (2). (Adapted from Godefroit et al., 1998, character 35).

(8) Dentary tooth row, shape in occlusal view: bowed lingually (0); tooth row divergent caudally and convergent rostrally relative to lateral side of dentary (1); tooth row parallel with lateral side of dentary (2). (Adapted from Horner et al., 2004, character 12).

(9) Dentary, ratio of length of proximal slope of edentulous portion (between first dentary tooth position and prementary joint)/dental battery length: ratio up to 5% (0); 10-20% (1); 25-33% (2); 40-50% (3); 60% or more (4). (Adapted from Horner et al., 2004, character 9).

(10) Dentary in dorsal view, angle between lateral face of dentary and symphysis: symphysis faces rostromedially relative to lateral surface of dentary (0); lateral dentary surface parallel with symphysis (1).

(11) Dentition, number of tooth positions in both dentary and maxillary dental batteries during ontogeny: up to 20 tooth positions (0); 25-30 (1); 35-40 (2); 42-45 (3); 50 or more (4). (Adapted from Hail-Lu You et al. 2003, character 31, and Horner et al., 2004, character 1).

(12) Dentition, number of replacement dentary teeth per tooth position (as seen in medial view): up to two (0); three or more (1). (Horner et al., 2004, character 2).

(13) Dentition, maximum number of functional teeth forming dentary occlusal plane: one (0); two (1); three (2). (Adapted from Horner et al., 2004, character 3).

(14) Dentition, ornamentation of labial enameled surface of dentary teeth: several ridges present (0); one well developed ridge plus a vestigial, faint secondary one (1); only one ridge present (2). (Adapted from Horner et al., 2004, character 6).

(15) Surangular, lateral exposure of undersurface of quadrate articulation: facing more laterally than ventrally (0); facing lateroventrally, in some individuals more ventrally than laterally (1).

(16) Surangular foramen: present (0); absent (1). (Horner et al. 2004, character 19).

Facial characters

(17) Maxilla, rostral portion: it has a separate rostradorsal process that extends medial to posteroventral process of premaxilla to form part of medial floor of external naris (0); rostradorsal process absent, rostradorsal margin of maxilla forms sloping shelf that underlies premaxilla (1). (Adapted from Horner et al., 2004, character 42).

(18) Maxilla, shape of dorsal process: low and gently rounded (0); tall and sharply peaked (1). (Horner et al., 2004, character 48).

(19) Maxilla, craniocaudal breadth of base of dorsal process: narrow, less than one third of total length of maxilla (0); broad, one third or more of total length of maxilla (1).

(20) Maxilla, ratio between length of segment rostral to dorsal process (along rostroventral process or rostradorsal shelf) and length of ectopterygoid shelf: approximately equal to 1 (0); longer rostral segment, but less than twice length of ectopterygoid shelf (1); very long rostral portion, twice or more length of ectopterygoid shelf (2). (Adapted from Hai-Lou You et al., 2003, character 12).

(21) Maxilla, number and arrangement of foramina: four or more foramina arranged in a subhorizontal row along lateral wall of maxilla (0); three or four foramina variously arranged (1).

(22) Ectopterygoid ridge on lateral side of maxilla: craniocaudally short, ending at half or less length of caudal region of maxilla (0); well developed into a lateral and well demarcated border continuous along caudal region of maxilla (1). (Adapted from Godefroit et al., 2001, character 15).

(23) Maxilla, orientation of ectopterygoid shelf: it slopes caudoventrally 30° or more (0); it slopes caudoventrally less than 30° (1); subhorizontal (2).

(24) Maxilla, morphology of lateral surface of rostroventral process: presence of a ridge lateral and ventral to premaxillary articulation surface (0); presence of a ridge lateral and ventral to premaxillary articulation surface; ridge forms a steep angle with longitudinal ax of maxilla (1); presence of a sharp ridge lateral to a deeply incised premaxillary articulation surface; lateral wall of rostroventral process, ventral and adjacent to ridge, forms a thick and flat face (2).

(25) Maxilla, location of line of alveolar foramina on medial surface: located ventral to midline of medial wall of maxilla, so that distance between dorsal margin of maxilla and line of foramina equals 65% (or more) of total dorsoventral depth of bone (0); located dorsal to midline of medial wall of maxilla, so that distance between dorsal margin of maxilla and line of foramina equals 40-45% of total dorsoventral depth of bone (1); located dorsal to midline of medial wall of maxilla, so that distance between dorsal margin of maxilla and line of foramina equals 25-33% of total dorsoventral depth of bone (2).

(26) Maxilla, location of jugal articulation relative to ectopterygoid shelf: jugal joint elevated dorsal to level of lateral ridge of ectopterygoid shelf (0); ventral margin of rostral process of jugal articulates flush with level of lateral margin of ectopterygoid shelf (1).

(27) Maxilla-jugal contact: restricted to finger-like jugal process on caudal margin of maxilla (0); jugal process of maxilla reduced to a short projection but retaining a distinct facet (1); jugal process of maxilla lost, rostral jugal has an extensive vertical contact with maxilla rostral to orbit (2). (Horner et al., 2004, character 46).

(28) Jugal, rostral process morphology: dorsoventrally narrow and thinning rostrally (0); triangular and symmetrical (1); triangular, asymmetrical, with apex displaced to dorsal half of process (2); truncated rostral end of (moderately expanded) rostral process of jugal or triangular

in shape with apex displaced ventrally (3); truncated and dorsoventrally expanded (4). (Adapted from Weishampel et al., 1993, characters 14 and 15).

(29) Jugal, medial side of rostral process: articulation surface faces medioventrally (0); articulation surface faces medially (1).

(30) Jugal, morphology of caudoventral flange and quadratojugal process and its constriction: D-shaped flange, moderately salient and continuous caudoventrally with a moderately wide quadratojugal process, which lacks a constriction; ventral margin of flange ventrally displaced relative to ventral border of rostral process of jugal (0); flange forms a wide and open arch, only slightly salient, its ventral edge being at same level as edge of rostral process, and quadratojugal process constriction as wide as rostral constriction (1); D-shaped flange, so salient that it is 40% deeper than quadratojugal process constriction, with ventral edge of flange located more ventrally relative to level of ventral edge of rostral process, and width of quadratojugal process constriction smaller than breadth of rostral constriction (2); D-shaped flange, moderately salient so that it is less deep than quadratojugal process constriction, with ventral edge of flange located more ventrally relative to level of ventral edge of rostral process, and quadratojugal process constriction as wide as rostral constriction (3); D-shaped flange, moderately salient and continuous posteroventrally with very wide quadratojugal process, which has a slight, or even may lack, constriction; ventral edge of flange ventrally displaced relative to ventral border of rostral process of jugal (4); D-shaped flange, moderately salient and continuous caudoventrally with a very slight constriction of quadratojugal process; ventral edge of flange at same level as pointed ventral border of rostral process of jugal (5); flange V-shaped, forming a pointed corner and its ventral edge caudoventrally continuous with un

unconstricted quadratojugal process (6). (Adapted from Horner et al., 2004, characters 55 and 56).

(31) Lacrimal, overall shape: triangular, with short rostroventral process (0); triangular with very long and gradually wedging rostral process, straight ventral edge along rostral three quarters of process (1); triangular with moderately long and gradually wedging rostral process, which has a ventral edge bearing a convex profile (2); triangular with moderately long rostroventral process that wedges abruptly more ventrally than rostrally (3).

(32) Prefrontal, dorsal crest: absent (0); present (1).

(33) Prefrontal, profile of rostradorsal orbital rim: smoothly curved (0); rostrally broad with squared anteromedial corner (1). (Horner et al., 2004, character 50).

(34) Prefrontal, expansion at rostradorsal orbit rim: prefrontal lies flush with surrounding elements (0); prefrontal flares dorsolaterally to form a thin and everted wing-like rim around anterodorsal orbit margin (1). (Horner et al. 2004, character 49).

(35) Postorbital, caudal face of jugal process: flat dorsally but concave ventrally along jugal joint (0); excavated into a deep and continuous groove, not only along ventral segment of jugal process, but also dorsally (1).

(36) Postorbital, dorsal border of central body: flat or gently concave (0); strongly concave, with V or U-shaped lateral profile (1).

(37) Postorbital, length of squamosal process: short, postorbital-squamosal joint reaches a point at mid length of supratemporal fenestra (0); long, postorbital-squamosal found near level of caudal border of supratemporal fenestra (1).

(38) Quadrate, development of caudodorsal squamosal process: prominent, forms a spike-like protuberance (0); weakly developed, forms a shallow relief (1); absent (2).

- (39) Quadrate, location of quadratojugal notch: centered approximately on middle third of quadrate (0); centered on dorsal half of ventral half of quadrate (1).
- (40) Quadrate, aperture of quadratojugal notch: notch describes a C-shaped, closed arch deep into lateral wall of quadrate (0); notch consists on a wide more or less symmetrical embayment (1); notch consists on a wide asymmetrical embayment, with a more extensive dorsal half of articulation surface (2). (Adapted from Horner et al., 2004, character 61).
- (41) Quadrate, overall curvature of its long axis: quadrate bent producing a concave relieve along its caudal border (0); quadrate straight or only slightly bent (1).
- (42) Squamosal, shape of caudolateral surface: shallowly exposed in caudal view (0); form a deep, near vertical, well-exposed face in caudal view (1). (Horner et al. 2004, character 64).
- (43) Squamosals on skull roof, separation: widely separated (0); squamosals approach midline, separated by narrow band of parietal (1); squamosals have broad contact with each other (2). (Horner et al. 2004, character 63).
- (44) Squamosal, length of prequadratic process: as long as quadrate cotylus (0); short, only 60 % breadth of quadrate cotylus (1); long, about 20% longer than breadth of quadrate cotylus (2).
- (45) Squamosal, caudomedial process: curved rostromedially, so that both squamosals describe a V-shaped outline in dorsal view on caudal border of skull roof (0); straight and medially directed, producing a subhorizontal caudal border of skull roof (1).
- (46) Supratemporal fenestra, proportions: rectangular, 1/3 longer rostrocaudally than wide mediolaterally (0); rostrocaudally abbreviated and squared (1); ovoid and elongated with main axis anterolaterally-directed (2); rostrocaudally abbreviated and ovoid, long axis rostromedially-directed (3).

(47) Frontal, upward doming over braincase: absent (0); present (1). (Horner et al. 2004, character 58).

(48) Frontal, morphology of nasofrontal suture: irregular and with indentations, forming less than 25% of frontal surface (0); W-shaped and forming 65% of frontal surface (1); grooved frontal surface, forming most of rostrocaudal length of frontal (2); semicircular, and forming 40-50% of surface of frontal (3); straight mediolaterally, reduced to less than 20% frontal surface and forming a very steep, ventrally-facing slope (4).

(49) Frontal contribution to dorsal orbital margin: it forms part of dorsal rim of orbit by being interposed between prefrontal and postorbital (0); frontal does not form part of orbital rim, but it not separated at very rim by prefrontal and prefrontal, which leave a small space in between (1); frontal excluded from orbital rim by postorbital-prefrontal joint (2). (Adapted from Horner et al., 2004, character 57).

(50) External naris, outline: ellipsoidal, variably elongated (0); rounded and well demarcated rostrally and V-shaped caudodorsally (1); conical and long: rostrally open and wide, weakly demarcated and, caudodorsally, wedge-shaped (2); teardrop-shaped and restricted to rostral third of premaxilla (3).

(51) External naris length relative to basal skull length: less than 20-25% (0); 33-40 % (1); 50% (2); 60-70% (3). (Adapted from Horner et al., 2004, character 28).

(52) External naris, composition of caudodorsal margin: formed equally by nasal dorsally and premaxilla ventrally (0); formed dorsally and caudally by nasal, and, ventrally, by caudoventral process of premaxilla ventrally (1); formed dorsally, caudally, and mostly ventrally by nasal, with a small contribution of premaxilla along ventral border of caudal margin of external naris (2); formed by nasal, which has a short, wedge-like ventral process that prevents caudoventral

process of premaxilla from participating in ventral curvature of caudal margin of external nar (3); formed by entirely by two lobes of premaxilla (4). (Adapted from Horner et al., 2004, character 29).

(53) Circumnarial fossa: absent (0); present (1). (Adapted from Horner et al., character 31).

(54) Circumnarial fossa, morphology: limited to rostroventral side of external naris (0); present and lightly incised into nasals and premaxilla, often poorly demarcated (1); present, well demarcated and incised (2); present, deeply incised and invaginated (3). (Adapted from Horner et al., 2004, characters 31 and 32).

(55) Solid nasal crest that does not house a portion of nasal passage: absent (0); present (1). (Horner et al., 2004, character 38).

(56) Solid nasal crest, composition and structure: composed of nasals, not excavated by circumnarial fossa (0); composed of nasals, excavated caudodorsally by circumnarial fossa (1); composed of frontals and nasals (2). (Adapted from Horner et al., 2004; character 38).

(57) Supraorbital hollow premaxillonasal crest: absent (0); present (1). (Adapted from Horner et al., 2004, character 34).

(58) Supraorbital hollow crest, nasal-caudodorsal process of premaxilla contact: rostral end of nasal fits along ventral edge of premaxilla (0); premaxilla and nasal meet in a complex, W-shaped interfingering suture (1). (Adapted from Horner et al., 2004, character 34)

(59) Supraorbital hollow crest, relative shape of two lobes of caudoventral process of premaxilla: rostral lobe higher than caudal lobe (0); caudal lobe higher than rostral lobe (1). (Horner et al., 2004, character 35).

(60) Supraorbital hollow nasal crest, shape: tubular and elongate (0); raised into a large, vertical fan. (Horner et al., 2004, character 36).

- (61) Supraorbital hollow nasal crest, composition of caudal margin: composed of premaxilla caudodorsal process (0); composed of nasal (1). (Horner et al., 2004, character 37).
- (62) Infratemporal fenestra, outline of dorsal half: subrectangular, variably rounded or squared, but as wide or wider than ventral margin (0); triangular, but narrower than ventral margin (1).
- (63) Premaxilla, mediolateral expansion of oral margin: narrow, expanded laterally less than twice width of narrowest point of post-oral constriction, oral margin oriented nearly vertically (0); 50% wider than narrowest point of post-oral constriction, but no more than 50% breadth across jugal arches (1); more than 50% wider than narrowest point of post-oral constriction and 60-70% of breadth across jugal arches (2); very expanded to reach a width nearly equal to that across jugal arches (3). (Adapted from Sereno, 1986 and Horner et al., 2004).
- (64) Premaxilla, morphology of oral and lateral rim: relatively thick, smooth and lateroventrally sloping border, with semicircular oral rim (0); reflected caudoventrally but forming a triangular deflected corner rostroventrally, oral margin arcuate rostrally but abruptly constricted caudally before continuing into lateral rim (1); reflected orally and posterolaterally, with a semicircular and broad oral margin (2); deeply invaginated rostrally with a thick rostral “lip” and reflected posterolaterally, with an extensive semicircular oral margin that continues smoothly into lateral rim of premaxilla (3); unreflected, with a deflected rostroventral corner, oral margin horse-shoe shaped with caudal constriction, and lateral border of premaxilla thickened into a ventral premaxillary lobe (4).
- (65) Premaxillary accessory fossa: absent (0); present (1). (Adapted from Horner et al., 2004, character 26).
- (66) Premaxillary accessory fossa, morphology: separated from circumnarial fossa by an oblique and rostroventrally directed convexity (0); present and partially separated from circumnarial

fossa by a well demarcated but shallow ridge (1); present and partially separated from circumnarial fossa by a transversal and tall, bifurcating ridge (2). (Adapted from Horner et al., 2004, character 26).

(67) Premaxillary foramen, rostroventral to rostral margin of external naris, which opens onto palate: absent (0); present (1). (Adapted from Weishampel et al., 1993).

(68) Premaxillary foramen, location: located adjacent to rostroventral margin of external naris(0); present, but separated from rostroventral margin of external naris(1); present, located ventrolaterally and adjacent to ridge that separates accessory and circumnarial fossae (2). (Adapted from Weishampel et al. 1993).

(69) Premaxilla, accessory foramen on outer (= accessory) narial fossa, located rostral to premaxillary foramen: absent (0); present (1). (Adapted from Horner et al., 2004, character 24).

(70) Premaxilla, accessory foramen arrangement: empties into common chamber with premaxillary foramen, onto palate (0); present and accompanied by additional foramina (1). (Adapted from Horner et al. 2004, character 24).

(71) Premaxilla, oral margin with a double layer consisting of an external denticle-bearing layer and an internal palatal one of thickened bone, set slightly caudally to oral margin and separated from denticular layer by a deep sulcus with vascular foramina: absent (0); present (1). (Horner et al., 2004, character 25).

Palatal characters

(72) Pterygoid, elevation of proximal quadrate wing over medial buttress: low (0); high (1).

(73) Pterygoid, size of ventral process of ventral quadrate ramus relative to ventral process that articulates with maxilla and ectopterygoid: equal in size (0); larger process of ventral quadrate ramus (1).

(74) Pterygoid, aperture between ventral process that contacts maxilla and ectopterygoid, and ventral quadrate ramus: wide (0); narrow (1).

(75) Pterygoid, ventral margin of wall of main central plate: only a small portion of quadrate ramus and rostroventral process extends ventrally beyond pterygoid main body wall, which has a straight ventral border (0); a greater portion of quadrate ramus and rostroventral process extends ventrally beyond pterygoid main body wall, which has a semicircular ventral border (1).

Neurocranial characters

(76) Laterosphenoid, relative length of postorbital process: short, less than twice length of orbitosphenoid maximum diameter (0); long, twice length of orbitosphenoid maximum diameter (1).

(77) Parasphenoid, length of cultriform process: as long as mediolateral width across both basipterygoid processes (0); longer than mediolateral width across both basipterygoid processes (1).

(78) Parasphenoid, distal mediolateral breadth of cultriform process: moderately expanded, less than 50% thicker distally than its minimum diameter (0); very expanded, 50% thicker distally than its minimum diameter (1); unexpanded or thinner distally (2).

(79) Parasphenoid, inclination of cultriform process: gently inclined rostr dorsally (0); steeply inclined rostr dorsally (1).

- (80) Exoccipital roof length: moderate, more than a half but less than diameter of foramen magnum (0); short, less than half diameter of foramen magnum (1); long, up to three times diameter of foramen magnum (2).
- (81) Occipital condyle inclined caudoventrally (0); vertically (1). (Godefroit et al. 2000, character 1).
- (82) Basisphenoid, alar process: of moderate size (0); extensive (1).
- (83) Basisphenoid, orientation of basipterygoid processes: transversely (straight) oriented as seen in ventral view and lateroventrally directed (0); rostromedially oriented as seen in ventral view and lateroventrally directed (1); caudolaterally oriented and lateroventrally directed (2).
- (84) Basipterygoid process, length: short (0), long, extending well below level of ventral border of occipital condyles (1). (Godefroit et al., 2000, character 2).
- (85) Basioccipital, contribution to ventral margin of foramen magnum: absent, exoccipital condyloids meet and exclude basioccipital from forming part of foramen magnum (0); present, condyloids separated allowing basioccipital to form mid portion of ventral margin of foramen magnum (1). (Weishampel et al., 1993, character 24).
- (86) Supraoccipital contribution to foramen magnum: present (0), absent (1). (Hai-Lu You et al. 2003, character 23).
- (87) Supraoccipital, inclination: caudal surface nearly vertical (0); caudal surface inclined steeply forward at approximately 45 degrees (1). (Horner et al. 2004, character 65).
- (88) Paroccipital process: ventrally directed (0); lateroventrally directed (1).
- (89) Paroccipital processes, proximodorsal ridges: distance between highest point of both ridges greater than distance between exoccipital roof and ventral surface of basioccipital (0); distance

between highest points of both ridges smaller than distance between exoccipital roof and ventral surface of basioccipital (1).

(90) Paroccipital process, mediolateral thickness of proximodorsal ridge: thin (0); thick (1).

(91) Parietal, midline crest: straight to slightly downwarped along its length (0); strongly downwarped, dorsal margin bends below level of postorbital-squamosal bar (1). (Horner et al. 2004, character 69).

(92) Parietal crest, length: relatively long, caudal parietal narrow quickly to form crest, crest more than half length of upper temporal fenestrae (0); relatively short, parietal crest narrows gradually caudally, crest less than half length of upper temporal fenestrae (1). (Horner et al., 2004, character 70).

(93) Parietal, exposure on occipital surface: present (0); excluded from occiput due to squamosal-to-squamosal joint (1). (Godefroit et al., 2000, character 4).

Vertebral characters

(94) Cervical vertebrae, number: up to 11 (0); 12 or more (1). (Horner et al., 2004, character 72).

(95) Cervical vertebrae, form of postzygapophyseal processes: weakly arched (0); strongly arched (1). (Hai-Lu You et al., 2003, character 42).

(96) Dorsal (posterior) and sacral neural spines, relative height: less than three times, but at least twice centrum height (0); elongate, more than three times centrum height (1); very short, less than twice centrum height (2). (Adapted from Horner et al., 2004, character 76).

(97) Sacral vertebrae, number: maximum of seven or less (0); eight to ten (1); more than ten (2). (Adapted from Godefroit et al., 2000, character 27).

Pectoral characters

(98) Scapula, shape of proximal region: dorsoventrally deep, acromion process directed dorsally, prominent on rostral margin of scapula, articulation extensive (0); dorsoventrally narrow (no wider than distal scapula), acromion process projects horizontally, reflected laterally, anteroventral corner notched, and articulation restricted (1). (Adapted from Norman, 2002, character 42).

(99) Scapula, shape of blade: dorsal and ventral margins slightly divergent and becoming subparallel distally, dorsal margin being slightly convex and ventral one slightly concave in lateral profile, proximal scapular constriction 80-90% as wide as widest region of distal blade (0); dorsal and ventral margins remarkably divergent, concave outline of ventral margin, with a moderately convex dorsal border, proximal scapular constriction 60% as wide as widest region of distal blade (1); dorsal and ventral margins remarkably divergent, dorsal one convex, ventral border concave proximally and slightly bowed, convex distally, where blade becomes between 40 and 50% wider than proximal scapular constriction (2); dorsal and ventral margins strongly divergent, slightly convex or nearly straight dorsal margin and concave outline of ventral margin, especially proximally, continuing distally into a well developed bowed convex profile, where blade becomes 50% wider than proximal scapular constriction (3); dorsal and ventral margins very divergent, slightly curved or straight, and distally blade becomes 50% wider than proximal scapular constriction (4). (Adapted from Norman, 2002, character 43).

(100) Sternal, relative length of caudolateral process ('handle'): short, as long as or less than 10% longer than craniomedial plate (0); long, between 25 and 30% longer than craniomedial plate (1). (Length of craniomedial plate measured from caudal edge of posteroventral process to rostral edge of sternal).

(101) Sternal, development of caudoventral process: short and narrow process, projects caudoventrally a distance that equal or less than average width of sternal 'handle' (0); well developed, projected a distance that twice as long as average width of scapular 'handle' and as thick as the last (1).

Forelimb characters

(102) Humerus, overall proportions: relatively long, length of long axis more than five times minimum diameter of distal half of bone (0); relatively short, length of long ax five or less times minimum diameter of distal half of humerus (1).

(103) Humerus, relative longitudinal length of deltopectoral crest: short, less than half length of humerus (0); extends to midshaft (1); long, extends to account at least for 60% of humerus length (2). (Adapted from Godefroit et al., 2000, character 26).

(104) Humerus, lateroventral projection of deltopectoral crest: mediolateral breadth across distal condyles larger or equal than maximum width of proximal segment of humerus (including deltopectoral crest, in craniomedial view) (0); mediolateral breadth across distal condyles smaller than maximum width of proximal segment of humerus (including deltopectoral crest, in craniomedial view) (1).

(105) Humerus, morphology of laterodistal margin of deltopectoral crest: margin merges smoothly with distal shaft (0); margin expanded and forms a well defined angulation (1).

(106) Humerus, position of caudal tuberosity: centered on middle of proximal half of humerus (defined by longitudinal extension of deltopectoral crest) (0); tuberosity center located ventral to middle of proximal half of humerus (1).

(107) Humerus length relative to ulnar length: humerus and ulna subequal in length (0); humerus shorter, reaching 70% of ulnar length by relative elongation of ulna (1); humerus shorter, reaching 80% of ulnar length by relative shortening of humerus (2). (Adapted from Norman, 2002, character 47).

(108) Carpus: uln, radiale, intermedium, and distal carpals present (metacarpal I fused onto carpus and divergent from rest of manus) (0); reduced to two small, unfused carpals (a tetragonal element and a minute pebble-like one) (1). (Adapted from Horner et al., 2004, character 86).

(109) Metacarpals, relative length of metacarpals III and IV: shorter than twice combined breadth of metacarpals II through IV (0); long, twice as long as combined breadth of metacarpals II through IV (1); very long and proportionately slender, more than twice as long as combined breadth of metacarpals II through IV (2).

(110) Metacarpal III, relative position of proximal end: aligned with that of metacarpals II and IV (0); offset distally relative to metacarpals II and IV (1). (Horner et al. 2004, character 88).

(111) Metacarpal II length relative to metacarpals III and IV: subequal (0); 80% length of metacarpals III and IV (1); short, 65% length of metacarpals III and IV (2).

(112) Metacarpal I: present and block-like, set against carpals (0); absent (1). (Norman, 2002, character 49).

(113) Metacarpal V, expansion of proximal surface relative to distal one: proximal and distal surfaces subequally expanded (0); proximal surface much more expanded relative to distal one (1).

(114) Manual phalanx III1, morphology: rectangular and proximodistally compressed (0); rectangular and almost equidimensional (1); subrectangular, but mediolaterally compressed (2).

Pelvic and hind limb characters

(115) Ilium, size of supraacetabular process: small, projects only as a lateral swelling (0); large, broadly overhangs lateral side of ilium and usually extends at least half way down side of ilium (1). (Godefroit et al., 2001, character 29).

(116) Ilium, shape of dorsal margin: nearly straight (0); distinctly depressed over supraacetabular process and dorsally bowed over base of preacetabular process (1). (Horner et al., 2004, character 100).

(117) Ilium, length of preacetabular process relative to length of postacetabular process: twice postacetabular process length (0); postacetabular process has two thirds of length of preacetabular process (1); postacetabular process has three fourths of length of preacetabular process (2).

(118) Ilium, depth of proximal region of preacetabular process: shallow, less than half dorsoventral depth of central body of ilium (from pubic peduncle to dorsal margin) (0); moderate, 50% depth of central body of ilium (1); deep, more than 50% depth of central body of ilium (2).

(119) Ilium, relative length of postacetabular process: shorter than antero-caudal length of central body of ilium (0); as long as central body of ilium (1).

(120) Ilium, morphology of postacetabular process (in lateral view): triangular, proximally broad and abruptly thinning distally to a blunt end (0); broad proximally and gradually becoming shallower distally into an end that 60-70% percent as deep as proximal region of process (1); subrectangular (2). (Adapted from Horner et al., 2004, character 93).

(121) Ilium, postacetabular process shape: tapers caudally to nearly a point, wide brevis shelf (0); rectangular, no brevis shelf (1). (Horner et al., 2004, character 93).

(122) Pubis, relative length of prepubic shaft constriction: long, dorsoventral expansion s abruptly as a distal oval process, constriction forms 60% of length of pubis from iliac peduncle to distal border of pubic blade (0); shaft shorter, dorsoventral expansion begins gradually at base of prepubic process and its length amounts to about 50% of length of pubis from iliac peduncle to distal border of prepubic blade; short constriction that forms 40% of total length of prepubic process (1). (Adapted from Horner et al., 2004, character 96).

(123) Pubis, minimum dorsoventral thickness of prepubic constriction relative to maximum expansion of distal blade: 50% (0); 30-40% (1); 60% (2).

(124) Pubis, morphology of lateral profile of dorsal and ventral margins of prepubic process: nearly symmetrical along prepubic constriction relative to frontal plane, slightly more pronounced arch along concave dorsal margin, and short and abrupt distal blade (0); nearly symmetrical along prepubic constriction relative to frontal plane, both ventral and dorsal margin describe wide arches, and distal blade subellipsoidal and elongated with smooth edges (1); nearly symmetrical along prepubic constriction relative to frontal plane, both ventral and dorsal margin describe wide arches, but distal blade reaches maximum expansion along its dorsal margin at a sharp corner, slopping cranioventrally parallel to ventral margin of distal pubic blade (2); nearly symmetrical along prepubic constriction relative to frontal plane, both ventral and dorsal margin describe wide arches, but distal blade abbreviated along its dorsal border, so that blade is more expanded cranioventrally along ventral margin (3); asymmetrical along prepubic constriction relative to frontal plane, so that ventral margin gently slopes cranioventrally, whereas dorsal border describes a semicircular, concave outline from cranial end of iliac process to maximum expansion of distal blade (4).

(125) Ischium, shape of shaft in lateral view: curved downward (0); nearly straight (1). (Adapted from Horner et al., 2004, character 98).

(126) Ischium, morphology of distal end: forming a triangular ventral expansion, not wider than twice average thickness of shaft (0); forming a foot-like ventral expansion, at least three times width of shaft (1); absence of foot-like expansion and, instead, a tapering straight end (2); absence of foot-like expansion and, instead, presence of a blunt, slightly expanded end curved caudoventrally (3). (Adapted from Godefroit et al., 2001, character 31).

(127) Ungual plantar ridge: absent (0); present (1).

