

APPENDIX

Character list. A full description of both character formulations and alternative coding regimes will be presented in a separate publication.

1. Presence (0) or absence (1) of a postbranchial lamina projecting from the anterior edge of the cleithrum.
2. Cleithrum attachment to scapulocoracoid: tripodal, via three processes of the scapulocoracoid (0); via a single dorsal process of the scapulocoracoid that lies flush against the internal surface of the cleithrum (1); complete fusion between surfaces of the scapula and cleithrum (2); separate bones (3).
3. Cleithrum anterior margin, in lateral aspect, inclined posteriorly for less (0) or more (1) than 10 degrees relative to the horizontal plane.
4. Presence (0) or absence (1) of cleithrum ornamentation.
5. Cleithrum with smoothly broadening to spatulate dorsal end (0); distal expansion marked from narrow stem by notch or process or decrease in thickness (1); simply tapering end (2).
6. Contact margin for clavicle on cleithrum: straight to gently convex (0); strongly concave (1).
7. Cleithrum without (0) or with (1) a narrow waisted region.
8. Cleithrum without (0) or with (1) a depressed posterior flange.
9. Cleithrum with (0) or without (1) an anteroventral process.
10. Cleithrum with (1) or without (0) a lateral ridge.
11. Cleithrum with (1) or without (0) a distinct shaft.
12. Cleithrum-clavicle pattern of overlap: rhizodont-like (0); not rhizodont-like (1).
13. Clavicle without (0) or with (1) anterolateral groove on its plate.
14. Clavicle plate morphology in ventral aspect and mesiolateral orientation: approximately elongate subtrapezoidal (0); subrectangular (1); equilateral triangular (2) elongate curved wedge (3); stout and spoon-shaped (4); elongate triangular with drawn out anterior margin (5); narrow and spatulate (6); elongate lozenge-shaped (7).
15. Clavicles meet anteriorly: yes (0); no (1).
16. Clavicles without (0) or with (1) a distinct ascending process.
17. Clavicles lying flush (i.e. to same ventral level as) with the cleithrum (0) or not (1).
18. Interclavicle posterior margin not drawn out into parasternal process (0); with parasternal process that is not parallel-sided (1); with elongate, slender process that is parallel-sided for most of its length (2).
19. Interclavicle unornamented (0); densely and finely perforated with fine striations (1); densely and coarsely perforated with ridges (2); punctate with widely spaced perforations (3); cancellose (4); with deep circular pits (5).
20. Interclavicle wider than long (excluding parasternal process, if present) (0) or not (1).
21. Interclavicle rhomboidal with posterior part longer (0) or shorter (1) than anterior part, the boundary between the anterior and posterior parts delimited by a transverse line running through its lateral corners.
22. Transversely elongate area of transversely oriented, subparallel, and interwoven grooves and ridges on central part of interclavicle ventral surface: absent (0); present (1).
23. Interclavicle small and scute-like (0); enlarged (1).
24. Separate scapular ossification: absent (0); present (1).
25. Glenoid subterminal, i.e. the scapulocoracoid does not extend ventral and slightly posterior to its posteroventral margin, and does not form a distinct 'wall' of bone, visible in lateral aspect: yes (0); no (1).
26. Supraglenoid foramen: present and funnel-shaped; (0) present, subcircular or subelliptical, and small-sized (1); present, subcircular or subelliptical, and medium-sized (2); present, subcircular or subelliptical, and large-sized (3); absent (4).
27. Ventromesially extended infraglenoid buttress, i.e. a thickening jutting out on the visceral (internal) side of the scapular blade, occurring posterior to the subscapular fossa, and sweeping mesioventrally towards the floor of the coracoid region of the scapulocoracoid: absent (0); present (1).
28. Glenoid oriented mostly posteriorly/ventrally (0) or with lateral component (1).
29. Subscapular fossa: absent (0); present (1).
30. Absence (0) or presence of poorly developed (1) or well developed (2) scapular blade.

31. Glenoid situated dorsal to the level of the clavicles (0) or offset ventrally at the same level as the clavicles (1).
32. Scapulocoracoid mostly concealed by cleithrum in lateral view (0) or mostly exposed (1).
33. Scapulocoracoid without (0) or with (1) expanded coracoid plate extending ventromedially.
34. Scapulocoracoid without (0) or with (1) supraglenoid excavation.
35. Glenoid greater axis oriented mostly horizontally (0) or obliquely (1).
36. Anocleithrum: present subdermal (0); present exposed (1); absent (2).
37. Supracleithrum: present, enlarged, bigger than scales (0); present, small, scale-like bone (1); absent (2).
38. Latissimus dorsi process of humerus offset anteriorly relative to the ectepicondyle (0) or aligned with the latter (1).
39. Distinct supinator process projecting anteriorly: absent (0); present (1).
40. Ventral humeral ridge: present oblique (0); present transverse (1); absent (2).
41. Latissimus dorsi process absent as recognisable structure (0); confluent with deltopectoral crest (1); distinct from (2) deltopectoral crest.
42. Entepicondyle foramen: present subcircular or elliptical (0); present slit-like (1); absent (2).
43. Ectepicondyle foramen: present (0); absent (1).
44. Distinct ectepicondyle ridge: present (0); absent (1).
45. Ectepicondyle ridge reaching distal humeral end: no (0); yes (1).
46. Distal extremity of ectepicondyle ridge aligned with ulnar condyle (0); between ulnar and radial condyles (1); aligned with radial condyle (2).
47. Humerus without (0) or with (1) waisted shaft.
48. Position of radial condyle: terminal (0); anteroventral (1); ventral (2).
49. Humerus length up to and no more than twice its width (0) or more than twice its width (1).
50. Posterolateral margin of entepicondyle lying distal relative to plane of radial and ulnar facets: yes (0); no (1).
51. Posterolateral margin of entepicondyle markedly concave: yes (0); no (1).
52. Width of entepicondyle greater (0) or smaller (1) than half humerus length.
53. Portion of humerus shaft length proximal to entepicondyle smaller (0) or greater (1) than humerus head width.
54. Accessory foramina on humerus: present three or more (0); present two or one (1); absent (2).
55. Humerus length greater (0) or smaller (1) than combined length of two and a half mid-trunk vertebrae.
56. Process '2' on humerus: absent (0); present (1).
57. Dorsoventrally flattened humerus: absent (0); present (1).
58. Broad shallow proximal depression for scapulohumeral muscle insertion: absent (0); present (1).
59. Enlarged area for muscle insertion above the radial condyle: absent (0); present (1).
60. Entepicondyle blunt- round-ended (0); truncated (1); with posterior margin smoothly convex and elongate, merging indistinctly into humerus shaft (2).
61. Caput humeri rounded to hemispherical shaped (0); subrectangular, much wider than high (1); elongate (bifid or strap - shaped) (2)
62. Radial and ulnar facets not separated (0) or separated (1) by finished bone.
63. Absence (0) or presence (1) of ventral process on entepicondyle.
64. Humerus anterior margin: smooth finished bone forming convex margin (0); anterior keel with finished margin (1); cartilage-finished (2); smooth concave margin (3).
65. Humerus ends untorted (0) or offset (1).
66. Length of posterior margin of entepicondyle smaller than (0), subequal to (1), or larger than (2) humerus anteroposterior length at the level of proximal insertion of entepicondyle onto humerus shaft.
67. Absence (0) or presence (1) of 'neck' below humeral head.
68. Absence (0) or presence (1) of distinct recess and incipient crest at proximal junction between ectepicondyle and entepicondyle processes.
69. Absence (0) or presence (1) of a dorsal thickening running along the posterior margin of the entepicondyle.
70. Ventral humeral ridge extending to posteromedial rim of entepicondyle (1) or not (0).
71. Absence (0) or presence (1) of distinct entepicondyle.
72. Absence (0) or presence (1) of distinct articular facets on proximal mesomere.
73. Absence (0) or presence (1) of processes 3 and 4 on entepicondyle.
74. Latissimus dorsi process a swelling (0) or a spike (1).
75. Pectoral process absent (0), present as a thin triangular thickening (1), present as a slightly protruding triangular process buttressed posteriorly (2), present as a strong process with wide buttressing (3).
76. Deltoid process absent or indistinct (0); forming round bulge at top of a crest (1); associated with dorsal ridge and slightly buttressed posteroproximally (2); conspicuous buttressed thickening (3).
77. Absence (0) or presence (1) of ectepicondylar depression.
78. Radius longer than (0) as long as (1), or shorter than (2) humerus.

79. Radius longer than (0), as long as (1), or shorter than (2) ulna.
80. Radius distal end blade-like (0); dagger-like (1); tapering smoothly (2); truncated (3); flared (4).
81. Radius absent (0), present and less than twice as long as wide at its midlength (1); at least twice as long as wide at its midlength (2).
82. Radius without (0) or with (1) distinctly expanded proximal extremity.
83. Olecranon process: absent (0); present (1).
84. Ulna wider at its distal extremity (0); of about the same width at proximal and distal extremities (1); wider at its proximal extremity (2).
85. Ulna maximum width greater than maximum bone length (0); between 100 and 50 percent of maximum bone length (1); less than 50 percent of maximum bone length (2).
86. Posterior margin of ulna drawn out (1) or not (0) into small round process.
87. Postaxial process of ulnare: present (0); absent (1).
88. Intermedium absent (0), present and longer than ulna (1), or about as long as ulna (2), or shorter than ulna (3).
89. Intermedium waisted and spool-shaped (0); dagger-like (1); splinter-shaped and tapering distally (2); simple rod (3); bulbous (4).
90. Anterior profile of ilium with distinct step in lateral aspect (0) or straight/shallowly concave (1).
91. Dorsal iliac process: absent (0); present and with dorsalmost part oriented vertically with posterior half of iliac neck (1); present and with dorsalmost part oriented vertically with anterior half of iliac neck (2).
92. Ventral margin of posterodorsal process of ilium forming acute angle with posterodorsal margin of ilium (0); oriented horizontally (1), forming right angle with posterodorsal margin of ilium (2); forming obtuse angle with posterodorsal margin of ilium (3).
93. Dorsal iliac process oblique and flared (0); fan-shaped (1); subrectangular and truncated (2); blunt and digitiform (3); low elongate (4).
94. Supraacetabular iliac buttress less (0) or more (1) prominent than postacetabular buttress.
95. Transverse pelvic ridge: absent (0); present (1).
96. Dorsal and posterodorsal iliac processes overlapping in lateral view (0) or separated by distinct space (1).
97. Mesial pelvic ridge offset anteriorly (0); aligned with iliac neck (1); absent (2).
98. Acetabulum directed posteriorly/posterolaterally (0) or laterally (1).
99. Acetabulum unfinished (1) or finished (0) anteriorly.
100. Absence (0) or presence (1) of distinct change in curvature or 'step' along ventral margin of posterodorsal process of ilium.
101. Posterodorsal process of ilium less (1) or more (0) than three times as long as wide.
102. Absence (0) or presence (1) of pelvic sutures.
103. Absence (0) or presence (1) of dorsal iliac ridge.
104. Ischium contributing to pelvic symphysis: no (0); yes (1).
105. Number of pubic obturator foramina: multiple (0); single (1); absent (2).
106. Sacral rib distinguishable by size: shorter than trunk ribs and longer than presacrals (1); same length as presacrals (0).
107. Sacral rib distinguishable by shape: broader than immediate presacrals but not broader than mid-trunk proximal shafts (0); broader than mid-trunk proximal shafts (1).
108. Internal trochanter raised as a distinct protuberance: absent (0); present (1).
109. Internal trochanter separated from the general surface of the femur shaft by a distinct, trough-like space: absent (0); present (1).
110. Fourth trochanter of femur with distinct rugose area: no (0); yes (1).
111. Proximal end of femur adductor crest reaching midshaft length: no (0); yes (1).
112. Femur shorter than (0), as long as (1), or longer than humerus (2).
113. Anterior distal condyle wider (1), as wide as (0), or less wide than (2) posterior distal condyle in extensor aspect.
114. Femur adductor blade distinguished distally from shaft by angle or notch (0) or fading into shaft distally (1).
115. Femur without (0) or with (1) distinctly expanded proximal head.
116. Femur without (0) distinct intercondylar groove on distal part of extensor surface; with groove, the length of which is less than (1) or more than (2) the distal width of the femur.
117. Anteroposterior maximum distance between femur distal condyles in extensor view 55 percent or more of femur length (0); between 55 and 40 percent of femur length (1); 40 percent or less than femur length (2).
118. Tibia waisted: no (0); yes (1).
119. Tibia without cnemial crest (0); crest present and running distally (1); present and running mesiolaterally while subsiding distally (2).
120. Tibia less than half (1) or more than half (0) of femur length.
121. Tibia without (0) or with (1) flange along its posterior edge.

122. Tibia distal articular surface absent (0); present and with L-shaped outline (1); present and with subelliptical outline (2).
123. Tibia width at mid-length of bone less than (0), comparable to (1), or greater than (2) width of fibula at mid-length of bone.
124. Tibia width at narrowest point 50 percent or more than bone length (0) or 30 percent or less than bone length (1).
125. Tibia and fibula without interepipodial space (0); with interepipodial space that is elongate and spindle-shaped (1); with broad interepipodial space (3) to which the tibia contributes in the form of a subsemicircular embayment, the diameter of which is less than one-third of the tibia length.
126. Tibia proximal extremity wider (0) or as wide as (1) its distal extremity.
127. Fibula waisted: no (0); yes (1).
128. Fibula without (0) or with (1) oblique distal extremity.
129. Ridge near posterior edge fibula flexor surface: absent (0); present (1).
130. Rows of tubercles near posterior edge fibula flexor surface: absent (0); present (1).
131. Postaxial process of fibula: present (0); absent (1).
132. Posterior (lateral) surface of fibula concave (0); straight (1); convex (2) in its proximal half.
133. Presence (0) or absence (1) of sulcus on anterodistal part of flexor surface of fibula.
134. Fibula width at narrowest point: 50 percent or more of bone length (0); 30 percent or less of bone length (1).
135. Proximal tarsal ossifications: absent (0); presence of single ossification (1); presence of more than two ossifications (2).
136. L-shaped proximal tarsal element: absent (0); present (1).
137. Distal tarsal ossifications between fibulare and digits: absent (0); present (1).
138. Distal tarsal ossifications between tibiale and digits: absent (0); present (1).
139. Manus digits: absent (0); present, eight (1); present, six (2); present, five (3); present, four (4).
140. Metacarpals absent (0); present and proximally symmetrical (1); proximally asymmetrical (2).
141. Length of longest metacarpal less than width of distal extremity of radius (0), as long as maximum oblique width of distal extremity of radius (1), or longer than maximum oblique width of distal extremity of radius (2).
142. Length of longest metacarpal less than twice its maximum width (0), at least twice as wide as long (1), more than twice as long (2).
143. Length of longest metacarpal no more than half length of radius (0), between half and total length of radius (1)
144. Pes digits: absent (0); present, eight (1); present, seven (2); present, six (3); present, five (4); present, four (5).
145. Metatarsals absent (0); present and proximally symmetrical (1); proximally asymmetrical (2).
146. Length of longest metatarsal not greater than maximum oblique width of distal extremity of tibia (0); up to 33 per cent longer (1); at least twice as long (2).
147. Length of longest metatarsal less than twice its maximum width (0); at least twice as wide as long (1); more than twice as long (2).
148. Length of longest metatarsal no more than half of the length of the tibia (0); between half and total length of the tibia (1).
149. Basal scutes: present (1); absent (0).
150. Radials: present unjointed (0); present jointed (1); absent (2).
151. Radials at pectoral level do not bifurcate (0) or bifurcate (1).
152. Lepidotrichia: present jointed (0); present unjointed (1); absent (2).
153. Lepidotrichia basal segments at pectoral level: long (0); short (1).
154. Mesomere 4 narrow or tapered (0); short, relatively broad (1); absent (2).
155. Mesomere 5 narrow and/or tapered (0); broadens posteriorly (1); absent (2).
156. Distal developmental domain of anterior appendage expanded across the anteroposterior axis (1) or not (0).
157. Distal developmental domain of posterior appendage expanded across the anteroposterior axis (1) or not (0).

Taxon references. For limb-bearing taxa, the reader is referred to Ruta *et al.*'s (2003) bibliography.

Below, I report exclusively works consulted for fin-bearing taxa. Cladistic characters and codings for these taxa were summarized from phylogenetic analyses in the relevant references.

Barameda decipiens: Long 1989; Garvey *et al.* 2005 (*Barameda* was treated as a composite genus, with additional data from *B. mitchelli*; Holland *et al.* 2007).

Eusthenopteron foordi: Andrews and Westoll 1970a.

Glyptolepis groenlandica: Ahlberg 1989.

Gogonasmus andrewsae: Long *et al.* 2006; Holland and Long 2009.

Marsdenichthys longioccipitus: Long 1985.

Medoevia lata: Lebedev 1995.

Megalichthys hibberti: Andrews and Westoll 1970b.

Onychodus jandemarrai: Andrews *et al.* 2006.

Panderichthys rhombolepis: Vorobyeva 1995; Boisvert 2005; Boisvert *et al.* 2008.

Rhizodopsis sauroides: Andrews and Westoll 1970b; Jeffery 2006; Friedman *et al.* 2007.

Rhizodus hibberti: Johanson *et al.* 2000; Jeffery 2001; Parker *et al.* 2005.

Sauripterus taylori: Davis *et al.* 2004.

Sterropterygion brandei: Rackoff 1980 (additional data kindly supplied by Professor Michael I. Coates, based upon his observations of this taxon).

Strepsodus sauroides: Johanson *et al.* 2000; Jeffery 2006.

Tiktaalik roseae: Shubin *et al.* 2006.

Data matrix. Polymorphic coding is denoted by the { } symbols; uncertain coding is denoted by the () symbols; question marks are used for both unknown and inapplicable conditions; characters are divided into groups of ten.

Acanthostega

0211000000 0002111100 0010010111 1110012001 1100100001 1001111111 2101000101
1110220204 200210?340 1000000111 0011010111 0100112011 0110010010 1000000011
0001100002 ??2211

Archeria

1311100011 1004111230 0010031112 0111122101 2010120011 101211111? 2001020110
1100330224 211220???1 2021111100 0101111101 1211121120 0211101110 1011211132
1004201102 ?2?2211

Asaphestera

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110?330??? ?0220???1 203?01?1?0 1101?????? ?{12}??1{12}???? ??????????
??????????{12} ??????????02 ?2?221?

Balanerpeton

1311100010 1002111040 0010?????? ?1????22?02 ?011??1011 100210111? 2003120?0?
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1(12)11201142 1104211102 ?2?2211

Baphetes

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11013302?4 21???????? 10{01}100?1?? ?1?1?????? ?????????12? 0{12}21101110
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Barameda

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Caerorhachis

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???42{12}210? ?2?????1

Catskill humerus

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110?100??? ?????????? ?????????? ?????????? ?????????? ?????????? ??????????
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Crassigyrimus

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1001?????? ??????????02 ?2?2211

Dendrerpeton

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1111201142 110?211102 ?2?2211

Eoherpeton

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Eucritta

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Eusthenopteron

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Glyptolepis

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Gogonasus

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Greererpeton

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111120?1{34}{12} 1004{12}00002 ?2?2211

Hynnerpeton

12110?0000 10????????? ???0021111 01100????? ?????????? ?????????? ??????????
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Ichthyostega

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Marsdenichthys

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Medoavia

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Megalichthys

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Onychodus

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Ossinodus

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Panderichthys

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Pederpes

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Pholiderpeton

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Proterogyrinus

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{12}004201102 ?2?2211

Ptyonius

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2215222102 ?2?2211

Rhizodopsis

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Rhizodus

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Sauripterus

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?????????00 ??????????01 ?10??1?

Sauropleura

1311000010 1005111020 1010??1??2 ?11??22?1? ?21??0211 1111001111 2003020???
110??0114 2112201??1 03??0??100 0101201?? ?21?122100 02111?11?? 12?120?142
2214222102 ?2?2211

Saxonerpeton

1311200010 1006111201 00101??112 011?022?02 ?111??1211 1112101112 2003120?0?
110?330224 2112201341 233101?100 1101?11100 1(12)(12)11{12}2101 0211101100
1111201142 ???4222102 ?2?2211

Scincosaurus

1311000011 1002011050 0010?4?1?2 0111022?12 ?0?????1211 1112001111 2003120???
110?330224 211220??1 03??0??100 1101201100 12??1?2101 02111011?? 1211????{34}2
2214222102 ?2?2211

Silvanerpeton

?311?0001? 1004111120 0010?????2 ?1?????2?0? ?0101?0001 1112001111 200?02011?
110??0224 210220??1 112??1?1?0 0101?11?? ?21?1211?0 ?111011?? 1{01}11201132
{12}{01}04211102 ?2?2211

Sterropterygion

?0?0?????? ?????????? ???0001010 ?000??00 ?00??0100 0000?00?10 2?00100??1
110?12?00{23} 2000100{12}{012}? ?????????? ?????????? ?????????? ??????????
?????????00 ?????????? ?01{01}?1?

Strepsodus

0000001110 0100?10??? ???0010000 0000000?00 00?0000200 101{01}?00001 0000021000
110?320?? ?000001?? ?????????? ?????????? ?????????? ?????0???? ??????????
?????????? ??????1?

Tiktaalik

0110010000 000{12}?00?? ????11111 1010011??0 00??11?(02)0? 0??0?01110
2111000000 110?120103 200111123? ?????????? ?????????? ?????????? ?????0????
?????????00 ??????????01 110111?

Trimerorhachis

?????????? ?0511?040 1011?31112 11?0?22110 2210121(01)10 1102001111 2001120100
11003302{12}4 211220??1 0(02)?11?11?0 1101??111 1221112121 0211101100
1101????42 ???42??02 ?2?2211

Tuditanus

13111?0010 1016111201 001?????? ????2?0? ?11??1011 1112101112 2003120???
110?3302{12}4 21?220??1 133101?100 11011??100 1?11122100 0211101100
1111{12}{01}1?42 1204222102 ?2?2211

Tulerpeton

?3110?0011 1015011{12}10 0010131112 0110012101 1010110101 1000??1111 2001020100
1100330214 2112201340 100??12?? ?1????111 020?122110 1121111101 1001211122
20032111?2 ?2?2211

Urocordylus

13111?0010 1005111010 1010??1??2 0111022?0? ?21??0211 1002001110 2001000?0?
110??0214 211220??1 03??0??100 1101211101 121?122100 02111011?? 12?1????32
2214222102 ?2?2211

Westlothiana

?????????? ?????????? ???0??1?12 ?1????112 2010121?11 1112001111 200312010?
1100330224 2112201341 1041011100 01011??110 12{01}1122101 1221101100
11112111{34}2 2114222102 ?2?2211

Whatcheeria

03111?0011 10?3011221 001(01){23}1?12 ?111022002 2010110(02)0(01) 1002?11111
200?02010? 1101330?? ?12?????1 1{01}1100?100 1(01)110110?? 0?011201?0
0?20211001 1100????? ??????????02 ?2?2211

