

# **A Toothed Turtle from the Late Jurassic of China and the Global Biogeographic History of Turtles**

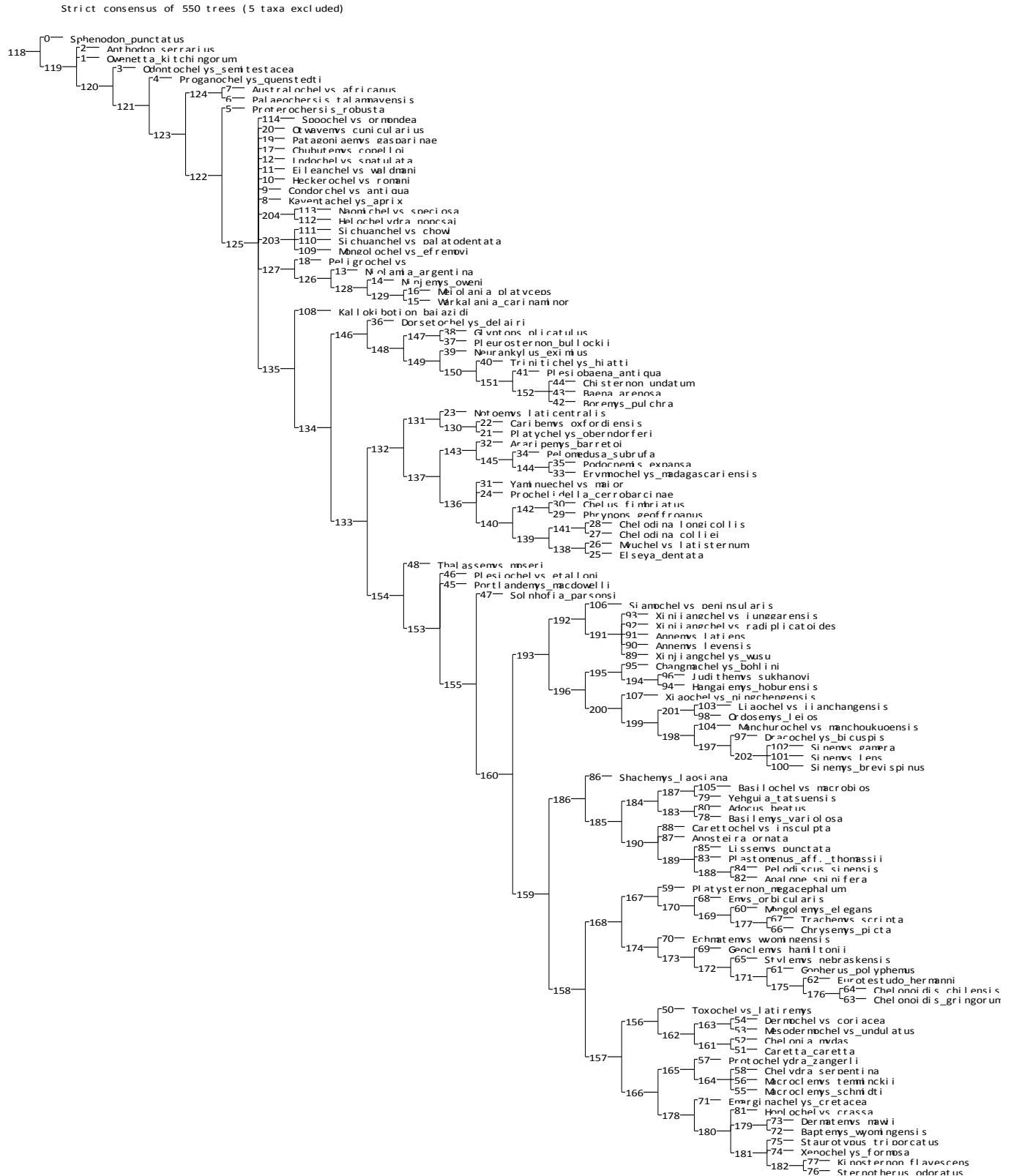
**Walter G. Joyce<sup>1\*</sup>, Márton Rabi<sup>2</sup>, James M. Clark<sup>3</sup>, Xing Xu<sup>4</sup>**

## **Additional file 3: Results of the phylogenetic analysis**

- A. Strict consensus topology resulting from 550 most parsimonious trees with 960 steps including all wildcard taxa
- B. Synapomorphies common to 550 trees
- C: Alternative positions of wildcard taxa
- D. Frequency differences values of standard bootstrap resampling of 1000 replicates
- E. Frequency differences values of standard bootstrap resampling of 1000 replicates with 5 wild card taxa excluded

# A. Strict consensus topology resulting from 550 most parsimonious trees with 960 steps including all wildcard taxa

Numbers denote nodes.



## B. Synapomorphies common to 550 trees

Numbers refer to nodes in consensus tree above.

Sphenodon\_punctatus :

All trees:

No autapomorphies:

Owenetta\_kitchingorum :

All trees:

Prefrontal\_A (3): medial\_contact\_on\_dorsal\_skull\_roof\_absent --> medial\_contact\_on\_dorsal\_skull\_roof\_present

Anthodon\_serrarius :

All trees:

Prefrontal\_E (7): absent --> prefrontal\_heavily\_sculptured\_present

Pterygoid\_B (56): basipt\_process\_present\_and\_movable\_articulation -->

basipt\_process\_present\_and\_sutured\_articulation

Some trees:

Humerus\_E\* (203): length\_of\_the\_humerus\_more\_than\_two\_times\_the\_width\_of\_the\_proximal\_end -->  
length\_of\_the\_humerus\_two\_times\_or\_less\_than\_the\_width\_of\_the\_proximal\_end

Odontochelys\_semitestacea :

All trees:

Cervical vertebra\_A (169): anterior\_end\_of\_the Centrum --> position\_of\_transverse\_processes\_middle\_of\_the\_Centrum

Manus\_A (215): most\_digits\_with\_two\_shortened\_phalanges --> most\_digits\_with\_three\_elongate\_phalanges

Proganochelys\_quenstedti :

All trees:

Prefrontal\_E (7): absent --> prefrontal\_heavily\_sculptured\_present

Prootic\_A\* (71): dorsal\_exposure\_large --> dorsal\_exposure\_reduced\_or\_absent

Caudal\_A (188): absent --> tail\_club\_present

Pes\_B (219): metatarsal\_V\_functions\_as\_a\_tarsal --> metatarsal\_V\_functions\_as\_true\_metatarsal

Some trees:

Humerus\_E\* (203): length\_of\_the\_humerus\_more\_than\_two\_times\_the\_width\_of\_the\_proximal\_end -->  
length\_of\_the\_humerus\_two\_times\_or\_less\_than\_the\_width\_of\_the\_proximal\_end

Proterochersis\_robusta :

All trees:

Xiphiplastron\_A (149): distinct\_anal\_notch\_absent --> present

Pelvis\_A (204): pelvis-shell\_attachment\_by\_ligaments --> ischium\_attached\_to\_plastron\_by\_a\_broad\_suture

Palaeochersis\_talampayensis :

All trees:

Maxilla\_D\*\_ (38): labial\_and\_lingual\_ridge\_present --> Triturating\_surface\_with\_only\_labial\_ridge\_present

Australochelys\_africanus :

All trees:

No autapomorphies:

Kayentachelys\_aprix :

Some trees:

Nasal\_C (2): dorsal\_exposure\_of\_nasal\_large --> greatly\_reduced\_relative\_to\_that\_of\_all\_other\_elements

Pterygoid\_A (55): absent --> pterygoid\_teeth\_present

Dentary\_A (107): medial\_contact\_of\_dentaries\_fused --> sutured\_only

Suprapygal\_A\* (124): two\_elements --> one\_element

Plastron\_B (132): present --> central\_plastral\_fontanella\_absent

Nuchal\_emargination (230): absent\_or\_indistinct, or present\_excludes\_peripheral\_1 -->  
deep\_and\_involves\_peripheral\_1

Condorchelys\_antiqua :

All trees:

No autapomorphies:

Heckerochelys\_romani :

All trees:

Epiplastron\_A (141): epiplastra\_and\_entoplastron\_narrow\_and\_elongate\_absent --> present

Some trees:

Pterygoid\_I (63): vertical\_flange\_on\_lateral\_process\_absent --> vertical\_falnge\_on\_lateral\_process\_present  
Musk\_ducts\_A\* (119): absent --> present  
Entoplastron\_B (137): size\_of\_posterior\_entoplastral\_process\_long --> short  
Entoplastron\_C (138): absent --> distinct\_posterolateral\_entoplastral\_process\_present  
Cervical\_articulation\_A (172): formed --> not\_formed

Eileanchelys\_waldmani :

Some trees:

Antrum\_postoticum\_A (49): incipient --> fully\_developed  
Peripheral\_gutter (228): peripheral\_gutter\_absent\_or\_only\_anteriorly\_developed -->  
peripheral\_gutter\_extensively\_developed\_along\_anterior\_and\_bridge\_peripherals  
Nuchal\_emargination (230): absent\_or\_indistinct, or present\_excludes\_peripheral\_1 -->  
deep\_and\_involves\_peripheral\_1

Indochelys\_spatulata :

Some trees:

Entoplastron\_A (136): absent --> anterior\_entoplastral\_process\_present  
Neural\_number (223): less\_than\_9\_elements --> 9\_elements

Niolamia\_argentina :

All trees:

Cranial\_scute\_C\* (91): yes --> Scute\_X\_much\_smaller\_than\_D\_scute\_no  
Cranial\_scute\_N\* (102): H\_scute\_present --> absent

Some trees:

Cranial\_scute\_K\* (99): A\_scute\_comparable\_in\_size\_to\_B\_scute --> A\_scute\_small\_A\_scute\_very\_large

Ninjemys\_oweni :

All trees:

Cranial\_scute\_F\* (94): low --> D\_scute\_high

Warkalania\_carinaminor :

All trees:

No autapomorphies:

Meiolania\_platyceps :

All trees:

Cranial\_scute\_E\* (93): Scutes\_A,\_B,\_and\_C\_forming\_a\_continuous\_posterolateral\_shelf\_yes --> no

Chubutemys\_copelloi :

Some trees:

Vomer\_B (41): vomer-ptyergoid\_contact\_in\_palatal\_view\_present --> absent,\_medial\_contact\_of\_palatines\_present  
Supraoccipital\_A (66): crista\_occipitalis\_poorly\_developed -->  
protruding\_significantly\_posterior\_to\_the\_foramen\_magnum

Peligrochelys :

Some trees:

Canalis\_caroticum\_F\* (87):  
Arteria\_palatina\_enters\_the\_skull\_through\_the\_interptyergoid\_vacuity\_or\_intraptyergoid\_slit -->  
through\_foramen\_posterius\_canalis\_carotici\_palatinum\_or\_split\_of\_branches\_enclosed\_in\_skull

Patagoniaemys\_gasparinae :

Some trees:

Cervical\_vertebra\_A (169): position\_of\_transverse\_processes\_middle\_of\_the Centrum --> anterior\_end\_of\_the\_Centrum  
Dorsal\_rib\_A (184): length\_first\_thoracic\_rib\_long\_extends\_full\_legth\_of\_first\_costal\_and\_may\_contact\_peripherals --  
> intermediate,\_in\_contact\_with\_axillary\_buttresses

Otwayemys\_cunicularius :

Some trees:

Mesoplastron\_A (146): 1\_or\_2\_pairs\_of\_meso\_with\_medial\_contact, or 1\_reduced\_pair --> absent  
Hypoplastron\_B\* (148): Inguinal\_buttress\_terminates\_on\_peripheral\_8 --> 6  
Extragular\_C (156): absent --> anterior\_plastral\_tuberosities\_present  
Abdominal\_A (163): present\_with\_medial\_contact --> present\_medial\_contact\_absent  
Dorsal\_rib\_A (184): length\_first\_thoracic\_rib\_long\_extends\_full\_legth\_of\_first\_costal\_and\_may\_contact\_peripherals --  
> intermediate,\_in\_contact\_with\_axillary\_buttresses

Platychelys\_oberndorferi :

All trees:

Musk\_ducts\_A\* (119): absent --> present

Supramarginal\_A (126): absent --> partial\_row\_present

Ilium\_B (209): positioned\_on\_costals\_only --> iliac\_scar\_extends\_from\_costals\_onto\_the\_peripherals\_and\_pygal

Caribemys\_oxfordiensis :

All trees:

Pubis\_B\* (207): cartilaginous\_or\_absent --> Epipubis\_process\_osseous\_or\_calcified

Notoemys\_laticentralis :

All trees:

No autapomorphies:

Prochelidella\_cerrobarcinae :

All trees:

No autapomorphies:

Elseya\_dentata :

All trees:

Maxilla\_D\* (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial,\_lingual\_and\_accesory\_ridges\_present

Myuchelys\_latisternum :

All trees:

Basisphenoid\_B (77): paired\_pits\_on\_ventral\_surface\_absent --> present

Chelodina\_colliei :

All trees:

No autapomorphies:

Chelodina\_longicollis :

All trees:

No autapomorphies:

Phrynops\_geoffroanus :

All trees:

Peripheral\_gutter (228): peripheral\_gutter\_absent\_or\_only\_anteriorly\_developed --> peripheral\_gutter\_extensively\_developed\_along\_anterior\_and\_bridge\_peripherals

Chelus\_fimbriatus :

All trees:

Nasal\_A (0): present --> absent

Prefrontal\_C (5): prefrontal-palatine\_contact\_absent --> prefrontal-palatine\_contact\_present

Premaxilla\_B (32): fusion\_of\_premaxilla\_absent --> present

Vomer\_D (43): absent --> vomer-premaxilla\_contact\_present

Carapace\_B (109): tricarinate\_carapace\_absent --> present\_and\_pronounced

Costal\_B (121): medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present -->

medial\_contact\_of\_posterior\_costals\_absent

Costal\_C (122): absent,\_costals\_fully\_or\_almost\_fully\_ossified,\_fontanelles\_abs\_or\_red --> present

Xiphiplastron\_B (150): xiphiplastra\_narrow\_absent --> present

Extragular\_B (155): medial\_contact\_of\_extragulars\_absent --> present,\_contacting\_one\_another\_posterior\_to\_gulars

Extragular\_C (156): absent --> anterior\_plastral\_tuberosities\_present

Extragular\_D\* (157): Only\_in\_the\_epiplastra --> Reach\_the\_entoplastron

Humeral\_B\* (160): Humero-pectoral\_sulcus\_only\_in\_the\_hyoplastra --> humero-pectoral\_sulcus\_crossing\_the\_entoplastron

Cervical vertebra\_B (170): ventral\_keels\_absent\_or\_slightly\_developed\_in\_all\_vertebrae --> ventral\_keels\_more\_developed\_on\_posterior\_vertebrae

Cervical vertebra\_C (171): cervical\_centrum\_8<7\_absent --> present

Yaminuechelys\_maior :

All trees:

Carapace\_D\* (111): Sculpturing\_of\_the\_shell\_absent --> present

Nuchal\_emargination (230): absent\_or\_indistinct, or present,\_excludes\_peripheral\_1 --> deep\_and\_involves\_peripheral\_1

Some trees:

Squamosal\_B (25): squamosal-supraoccipital\_contact\_absent --> present

Nuchal\_C\* (115): longer\_than\_wide\_or\_as\_long\_as\_wide --> wider\_than\_long

Ilium\_B (209): positioned\_on\_costals\_only --> iliac\_scar\_extends\_from\_costals\_onto\_the\_peripherals\_and\_pygal

Araripemys\_barretoi :

All trees:

Jugal\_B (20): jugal\_participation\_to\_upper\_temporal\_rim\_absent --> present  
Pterygoid\_G (61): medial\_contact\_of\_pterygoids\_present --> absent  
Carapace\_B (109): tricarinate\_carapace\_absent --> present\_and\_pronounced  
Carapace\_D\_\* (111): Sculpturing\_of\_the\_shell\_absent --> present  
Costal\_C (122): absent,\_costals\_fully\_or\_almost\_fully\_ossified,\_fontanelles\_abs\_or\_red --> present  
Entoplastron\_D (139): entoplastron\_V-shaped\_absent --> present  
Epiplastron\_A (141): epiplastra\_and\_entoplastron\_narrow\_and\_elongate\_absent --> present  
Mesoplastron\_A (146): 1\_reduced\_pair --> absent  
Hypoplastron\_A (147): peripheral\_and\_costal\_V --> inguinal\_buttresses\_contact\_peripherals\_only  
Hypoplastron\_B\* (148): Inguinal\_buttress\_terminates\_on\_peripheral\_8 --> 7  
Extragular\_A (154): present --> absent  
Abdominal\_A (163): present,\_with\_medial\_contact --> present,\_medial\_contact\_absent  
Posterior\_plastral\_fontanelle (222):

posterior\_plastral\_fontanelle\_between\_the\_xiphiplastra\_and/or\_the\_hypoplastra:\_absent\_in\_adult\_stage --> retained\_in\_adults

Neural\_number (223): less\_than\_9\_elements --> 9\_elements  
First vertebral (227): vertebral\_1\_does\_not\_enter\_anterior\_margin\_of\_carapace --> enters\_anterior\_margin  
Nuchal\_emargination (230): absent\_or\_indistinct, or present,\_excludes\_peripheral\_1 --> broad,\_involved\_peripheral\_II  
Cruciform\_plastron (232): absent --> present

Some trees:

Plastron\_A (131): connection\_between\_carapace\_and\_plastron\_osseous --> ligamentous

Erymnochelys\_madagascariensis :

All trees:

Hypoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1  
Extragular\_D\* (157): Only\_in\_the\_epiplastra --> Reach\_the\_entoplastron

Pelomedusa\_subrufa :

All trees:

No autapomorphies:

Podocnemis\_expansa :

All trees:

Maxilla\_A\* (36): do\_not\_contact\_each\_other\_in\_ventral\_view --> contacts\_each\_other\_in\_ventral\_view  
Maxilla\_E\* (39): Accessory\_ridge\_on\_maxilla\_present\_all\_along\_the triturating\_surface -->

accessory\_ridge\_only\_in\_some\_sectors\_of\_the triturating\_surface

Pterygoid\_H (62): pterygoid\_contribution\_to\_foramen\_palatinum\_posterius\_present --> absent

Dorsetochelys\_delairi :

All trees:

Basisphenoid\_B (77): paired\_pits\_on\_ventral\_surface\_absent --> present

Pleurosternon\_bullockii :

All trees:

Suprapygial\_A\* (124): two\_elements --> one\_element  
Cervical\_A (125): one\_cervical\_present --> cervicals\_absent,\_carapacial\_scutes\_otherwise\_present  
Gular\_A (153): one\_pair --> only\_one\_scute

Glyptops\_plicatulus :

All trees:

Premaxilla\_E (35): distinct\_medial\_premaxillary\_hook\_along\_the\_labial\_margin\_absent --> present  
Maxilla\_D\* (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial\_and\_lingual\_ridge\_present

Some trees:

Nuchal\_emargination (230): absent\_or\_indistinct --> present,\_excludes\_peripheral\_1

Neurankylus\_eximius :

All trees:

No autapomorphies:

Trinitichelys\_hiatti :

All trees:

No autapomorphies:

Plesiobaena\_antiqua :

Some trees:

Cervical\_articulation\_A (172): not\_formed --> formed

Boremys\_pulchra :

All trees:

No autapomorphies:

Baena\_arenosa :

All trees:

Parietal\_H\* (18): moderate\_f.s.t.\_but\_not\_entire\_processes\_trochlearis\_exposed\_in\_dorsal\_view --> absent\_or\_weak\_foramen\_stapedio-temporale\_concealed\_in\_dorsal\_view

Cranial\_scutes\_A\* (89): absent --> present

Nuchal\_C\* (115): wider\_than\_long --> longer\_than\_wide\_or\_as\_long\_as\_wide

Mesoplastron\_A (146): 1\_or\_2\_pairs\_of\_meso\_with\_medial\_contact --> 1\_reduced\_pair

Some trees:

Suprapygial\_A\* (124): two\_elements --> one\_element

Caudal\_D\* (191): posterior\_caudal\_vertebrae\_procoelous\_or\_platycoelous --> posterior\_caudal\_vertebrae\_opisthocelous

Chisternon\_undatum :

Some trees:

Cervical\_articulation\_A (172): not\_formed --> formed

Portlandemys\_macdowellii :

All trees:

No autapomorphies:

Plesiochelys\_etalloni :

Some trees:

Pterygoid\_F (60): foramen\_palatinum\_posterius\_present --> present\_but\_open\_laterally

Pterygoid\_J\* (64): reaching\_the\_exoccipitals --> not\_reaching\_the\_exoccipitals

Cervical\_A (125): one\_cervical\_present --> more\_than\_one\_cervical\_present

Solnhofia\_parsonsi :

All trees:

Maxilla\_C\*\_ (37):

Secondary\_palate\_formed\_by\_premaxilla\_maxilla\_and\_vomer\_palatines\_not\_contacting\_in\_midline\_absent --> formed\_by\_premaxilla\_maxilla\_and\_vomer\_palatines\_not\_contacting\_in\_midline\_present

Vomer\_B (41): vomer-ptyergoid\_contact\_in\_palatal\_view\_present --> absent\_medial\_contact\_of\_palatines\_present

Pterygoid\_I (63): vertical\_falnge\_on\_lateral\_process\_present --> vertical\_flange\_on\_lateral\_process\_absent

Suprapygial\_A\* (124): two\_elements --> more\_than\_2\_elements

Epiplastron\_A (141): epiplastra\_and\_entoplastron\_narrow\_and\_elongate\_absent --> present

Nuchal\_posterior\_edge (234): less\_than\_3\_times\_longer\_than\_the\_lateral\_edge --> more\_than\_3\_times\_longer

Thalassemys\_moseri :

All trees:

Vomer\_B (41): vomer-ptyergoid\_contact\_in\_palatal\_view\_present --> absent\_medial\_contact\_of\_palatines\_present

Prootic\_A\* (71): dorsal\_exposure\_large --> dorsal\_exposure\_reduced\_or\_absent

Some trees:

Pterygoid\_F (60): foramen\_palatinum\_posterius\_present --> present\_but\_open\_laterally

Opisthotic\_C (74): present\_with\_an\_incipient\_enclosed\_middle\_ear\_region -->

present\_but\_modified\_with\_a\_enclosed\_middle\_ear\_region

Dorsal\_rib\_A (184): length\_first\_thoracic\_rib\_long\_extends\_full\_legth\_of\_first\_costal\_and\_may\_contact\_peripherals --> intermediate\_in\_contact\_with\_axillary\_buttresses

Toxochelys\_latiremys :

All trees:

Anal\_A (164): only\_cover\_parts\_of\_the\_xiphiplastra --> anteromedially\_overlap\_onto\_hypoplastra

Cervical\_articulation\_L\* (180): present --> double\_articulation\_between\_7th\_and\_8th\_absent

Chevron\_A (192): absent\_or\_poorly\_developed\_along\_posterior\_caudals --> present\_on\_nearly\_all\_caudals

Caretta\_caretta :

All trees:

Quadrata\_H\* (52): Processus\_trochlearis\_oticum\_formed\_by\_a\_great\_contribution\_of\_quadrata --> small\_contribution\_of\_the\_quadrata

Peripheral\_A (118): 11\_pairs --> more\_than\_11\_pairs

Chelonia\_mydas :

All trees:

Premaxilla\_E (35): distinct\_medial\_premaxillary\_hook\_along\_the\_labial\_margin\_absent --> present

Maxilla\_D\* (38): Triturating\_surface\_with\_only\_labial\_ridge\_present, or labial\_and\_lingual\_ridge\_present --> labial\_lingual\_and\_accessory\_ridges\_present

Mesodermochelys\_undulatus :

All trees:

Cervical vertebra\_C (171): present --> cervical\_centrum\_8<7\_absent

Cervical articulation\_L\* (180): present --> double\_articulation\_between\_7th\_and\_8th\_absent

Articulation\_of\_posterior\_cervical\_centra (233): greatly\_flattened\_outline --> circular\_or\_subcircular\_outline

Dermodochelys\_coriacea :

All trees:

Carapace\_A (108): partially\_present --> absent

Peripheral\_A (118): 11\_pairs --> less\_than\_10\_pairs

Nuchal\_emargination (230): present\_excludes\_peripheral\_1, or deep\_and\_involves\_peripheral\_1 --> absent\_or\_indistinct

Macrolemys\_schmidti :

All trees:

Quadrate\_F\_incisura\_columella\_auris (50): present\_and\_closed\_but\_only\_enclosing\_the\_stapes --> partially\_closed\_allowing\_to\_see\_the\_columella\_auris\_in\_posterior\_view

Macrolemys\_temminckii :

All trees:

Supramarginal\_A (126): absent --> partial\_row\_present

Caudal\_C\* (190): anterior\_caudal\_vertebrae\_procoelous\_or\_platycoelous --> anterior\_caudal\_vertebrae\_opisthocoelous

Nuchal\_emargination (230): absent\_or\_indistinct --> deep\_and\_involves\_peripheral\_1

Protochelydra\_zangerli :

All trees:

No autapomorphies:

Chelydra\_serpentina :

All trees:

Suprapygal\_A\* (124): one\_element, or two\_elements --> more\_than\_2\_elements

Platysternon\_megacephalum :

All trees:

Parietal\_H\* (18): strong\_entire\_processus\_trochlearis\_exposed\_in\_dorsal\_view --> absent\_or\_weak\_foramen\_stapedio-temporale\_concealed\_in\_dorsal\_view

Quadratojugal\_B (22): quadratojugal-maxilla\_contact\_absent --> present

Premaxilla\_E (35): distinct\_medial\_premaxillary\_hook\_along\_the\_labial\_margin\_absent --> present

Quadrate\_F\_incisura\_columella\_auris (50): present\_but\_qu\_and\_the\_op\_for\_an\_angle\_less\_90\_degrees\_in\_lat\_view --> present\_and\_closed\_but\_only\_enclosing\_the\_stapes

Basisphenoid\_A (76): rostrum\_basisphenoidale\_flat --> rod-like\_thick\_and\_rounded

Neural\_B\* (117): regular\_often\_hexagonal\_longer\_than\_wide --> irregular\_in\_shape\_wider\_than\_long

Musk\_ducts\_A\* (119): absent --> present

Hyoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> terminates\_on\_peripheral\_4

Hypoplastron\_B\* (148): 7 --> 6

Cervical vertebra\_B (170): ventral\_keels\_more\_developed\_on\_posterior\_vertebrae --> ventral\_keels\_absent\_or\_slightly\_developed\_in\_all\_vertebrae

Caudal\_D\* (191): posterior\_caudal\_vertebrae\_procoelous\_or\_platycoelous --> posterior\_caudal\_vertebrae\_opisthocoelous

Chevron\_A (192): absent\_or\_poorly\_developed\_along\_posterior\_caudals --> present\_on\_nearly\_all\_caudals

Humerus\_A\* (199): only\_a\_groove --> Ectepicondylar\_foramen\_in\_a\_channel

Humerus\_D\* (202): lateral\_process\_not\_seen\_in\_dorsal\_view --> lateral\_process\_seen\_in\_dorsal\_view

Nuchal\_emargination (230): absent\_or\_indistinct --> deep\_and\_involves\_peripheral\_1

Tail\_length (231): tail\_clearly\_shorter\_than\_carapace --> tail\_as\_long\_as\_carapace

Nuchal\_posterior\_edge (234): less\_than\_3\_times\_longer\_than\_the\_lateral\_edge --> more\_than\_3\_times\_longer

Mongolemys\_elegans :

All trees:

Pterygoid\_H (62): absent --> pterygoid\_contribution\_to\_foramen\_palatinum\_posterius\_present

Basioccipital\_A (70): tubercle\_absent --> with\_two\_or\_one\_ventral\_basioccipital\_tubercle

Hyoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1



Chevron\_A (192): absent\_or\_poorly\_developed\_along\_posterior\_caudals --> present\_on\_nearly\_all\_caudals  
Carotid\_canal\_split (237): 3 -->  
not\_enclosed\_but\_carotid\_canal\_is\_covered\_ventrally\_from\_the\_posterior\_end\_of\_the\_skull

Gopherus\_polyphemus :

All trees:

Humerus\_A\* (199): only\_a\_groove --> Ectepicondylar\_foramen\_in\_a\_channel

Eurotestudo\_hermani :

All trees:

Prootic\_A\* (71): dorsal\_exposure\_large --> dorsal\_exposure\_reduced\_or\_absent

Hypoplastron\_A (147): peripheral\_and\_costal\_V --> inguinal\_buttresses\_contact\_peripherals\_only

Chelonoidis\_gringorum :

All trees:

Supramarginal\_A (126): absent --> complete\_row\_present

Chelonoidis\_chilensis :

All trees:

Vertebral\_C (129): on\_neural\_V --> sulcus\_between\_V\_3\_and\_4\_on\_neural\_VI

Stylomys\_nebraskensis :

All trees:

Hypoplastron\_A (147): peripheral\_and\_costal\_V --> peripherals\_costal\_V\_and\_costal\_VI

Pelvis\_A (204): pelvis-shell\_attachment\_by\_ligaments --> ischium\_attached\_to\_plastron\_by\_a\_broad\_suture

Pubis\_B\* (207): cartilaginous\_or\_absent --> Epipubis\_process\_osseous\_or\_calcified

Chrysemys\_picta :

All trees:

Pterygoid\_D (58): present --> pterygoid-basioccipital\_contact\_absent

Pectoral\_B\* (162): antero-posteriorly\_developed --> very\_short\_antero-posteriorly

Trachemys\_scripta :

All trees:

Parietal\_A (11): absent --> parietal-squamosal\_contact\_present

Maxilla\_E\*\_ (39): Accessory\_ridge\_on\_maxilla\_present\_all\_along\_the triturating\_surface -->  
accessory\_ridge\_only\_in\_some\_sectors\_of\_the triturating\_surface

Costal\_D\* (123): absence\_of\_alternative\_short\_and\_long\_ends\_in\_the\_lateral\_part\_of\_the\_costals --> presence

Emys\_orbicularis :

All trees:

Pterygoid\_D (58): present --> pterygoid-basioccipital\_contact\_absent

Plastron\_C (133): plastral\_kinesis\_absent --> present

Entoplastron\_B (137): short --> size\_of\_posterior\_entoplastral\_process\_long

Xiphoplastron\_A (149): present --> distinct\_anal\_notch\_absent

Geoclemys\_hamiltonii :

All trees:

Jugal\_B (20): jugal\_participation\_to\_upper\_temporal\_rim\_absent --> present

Prootic\_A\* (71): dorsal\_exposure\_large --> dorsal\_exposure\_reduced\_or\_absent

Carapace\_B (109): tricarinate\_carapace\_absent --> present\_but\_only\_slightly

Musk\_ducts\_A\* (119): absent --> present

Echmatemys\_wyomingensis :

All trees:

Hypoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1

Emarginachelys\_cretacea :

All trees:

No autapomorphies:

Baptemys\_wyomingensis :

All trees:

Hypoplastron\_A (147): inguinal\_buttresses\_contact\_peripherals\_only --> peripheral\_and\_costal\_V

Dermatemys\_mawii :

All trees:

Carapace\_B (109): present\_but\_only\_slightly --> tricarinate\_carapace\_absent  
Xiphiplastron\_A (149): distinct\_anal\_notch\_absent --> present  
Intergular\_A (158): absent --> present  
Humeral\_B\* (160): humero-pectoral\_sulcus\_crossing\_the\_entoplastron --> Humero-pectoral\_sulcus\_only\_in\_the\_hyo-plastra  
Cervical\_vertebra\_E\* (174): present --> Biconvex\_cervical\_vertebra\_in\_the\_middle\_of\_the\_neck\_absent  
Some trees:  
Costal\_B (121): medial\_contact\_of\_posterior\_costals\_absent -->  
medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present

Xenochelys\_formosa :

All trees:

Pterygoid\_F (60): foramen\_palatinum\_posterius\_present --> absent  
Nuchal\_C\* (115): wider\_than\_long --> longer\_than\_wide\_or\_as\_long\_as\_wide  
Xiphiplastron\_A (149): distinct\_anal\_notch\_absent --> present  
Nuchal\_emargination (230): absent\_or\_indistinct --> present\_excludes\_peripheral\_1

Staurotypus\_triporcatus :

All trees:

Carapace\_B (109): present\_but\_only\_slightly --> present\_and\_pronounced

Some trees:

Jugal\_B (20): jugal\_participation\_to\_upper\_temporal\_rim\_absent --> present  
Cruciform\_plastron (232): absent --> present

Sternotherus\_odoratus :

Some trees:

Cruciform\_plastron (232): absent --> present

Kinosternon\_flavescens :

All trees:

Musk\_ducts\_A\* (119): present --> absent  
Plastral\_kinesis\_A\* (134): anterior --> anterior\_and\_posterior  
Pubis\_B\* (207): Epipubis\_process\_osseous\_or\_calcified --> cartilaginous\_or\_absent

Basilemys\_variolosa :

All trees:

Extragular\_D\* (157): Only\_in\_the\_epiplastra --> Reach\_the\_entoplastron  
Inframarginal\_B\* (166): 3\_or\_more --> 2  
Manus\_A (215): most\_digits\_with\_three\_elongate\_phalanges --> most\_digits\_with\_two\_shortened\_phalanges  
Nuchal\_emargination (230): absent\_or\_indistinct --> deep\_and\_involves\_peripheral\_1

Yehguia\_tatsuensis :

All trees:

Humeral\_B\* (160): humero-pectoral\_sulcus\_crossing\_the\_entoplastron --> Humero-pectoral\_sulcus\_only\_in\_the\_hyo-plastra

Adocus\_beatus :

All trees:

Pectoral\_B\* (162): antero-posteriorly\_developed --> very\_short\_antero-posteriorly  
Ilium\_E\* (212): thelial\_process\_absent --> present

Hoplochelys\_crassa :

All trees:

Carapace\_B (109): present\_but\_only\_slightly --> present\_and\_pronounced  
Epiplastron\_B\* (142): thick\_anterior\_border\_absent --> thick\_anterior\_border  
Hyo-plastron\_B\* (145): terminates\_on\_peripheral\_3 --> Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1

Apalone\_spinifera :

All trees:

Maxilla\_D\*\_ (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial\_and\_lingual\_ridge\_present

Plastomenus\_aff.\_thomassii :

All trees:

No autapomorphies:

Pelodiscus\_sinensis :

All trees:

Pterygoid\_H (62): absent --> pterygoid\_contribution\_to\_foramen\_palatinum\_posterius\_present

Lissemys\_punctata :

All trees:

Pterygoid\_I (63): vertical\_falnge\_on\_lateral\_process\_present --> vertical\_flange\_on\_lateral\_process\_absent

Hyo-hyoplastron\_A\* (144): not\_fused --> fused

Some trees:

Foramen\_jugulare\_posterius\_B\* (85): separated\_by\_opisthotic\_and\_or\_exoccipital --> separated\_from\_fenestra\_postotica\_by\_pterygoid

Shachemys\_laosiana :

All trees:

Prootic\_A\* (71): dorsal\_exposure\_large --> dorsal\_exposure\_reduced\_or\_absent

Nuchal\_C\* (115): wider\_than\_long --> longer\_than\_wide\_or\_as\_long\_as\_wide

Costal\_B (121): medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present --> medial\_contact\_of\_all\_costals\_present

Cervical\_A (125): one\_cervical\_present --> cervicals\_absent\_carapacial\_scutes\_otherwise\_present

Vertebral\_B (128): vertebrae\_II-IV\_narrower\_or\_as\_narrow\_as\_pleurals --> vertebral\_II-IV\_broader\_than\_pleurals

Anosteira\_ornata :

All trees:

Nuchal\_emargination (230): absent\_or\_indistinct --> present\_excludes\_peripheral\_1

Carettochelys\_insculpta :

All trees:

Quadratojugal\_B (22): quadratojugal-maxilla\_contact\_absent --> present

Some trees:

Humerus\_C\* (201): lateral\_process\_in\_the\_proximal\_end\_of\_the\_humerus --> displaced\_from\_the\_proximal\_end\_located\_in\_the\_shaft\_of\_the\_humerus

Xinjiangchelys\_wusu :

All trees:

Plastral\_scutes\_B (152): present --> pronounced\_midline\_plastral\_sulcus\_sinuuous\_absent

Annemys\_levensis :

All trees:

Costal\_B (121): medial\_contact\_of\_posterior\_costals\_absent -->

medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present

Vertebral\_C (129): on\_neural\_V --> sulcus\_between\_V\_3\_and\_4\_on\_neural\_VI

Some trees:

Nuchal\_emargination (230): present\_excludes\_peripheral\_1 --> deep\_and\_involves\_peripheral\_1

Annemys\_latiens :

Some trees:

Nuchal\_emargination (230): present\_excludes\_peripheral\_1 --> deep\_and\_involves\_peripheral\_1

Xinjiangchelys\_radiplicatoides :

All trees:

No autapomorphies:

Xinjiangchelys\_junggarensis :

All trees:

No autapomorphies:

Hangaiemys\_hoburensis :

All trees:

Pterygoid\_J\* (64): reaching\_the\_exoccipitals --> not\_reaching\_the\_exoccipitals

Foramen\_jugulare\_posterius\_A\* (84): coalescent\_with\_fenestra\_postotica --> separated\_from\_fenestra\_postotica

Changmachelys\_bohlini :

All trees:

No autapomorphies:

Judithemys\_sukhanovi :

All trees:

Peripheral\_gutter (228): peripheral\_gutter\_extensively\_developed\_along\_anterior\_and\_bridge\_peripherals --> peripheral\_gutter\_absent\_or\_only\_anteriorly\_developed

*Dracochelys bicuspis* :

All trees:

Maxilla\_D\* (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial\_and\_lingual\_ridge\_present

Basioccipital\_A (70): with\_two\_or\_one\_ventral\_basioccipital\_tubercle --> tubercle\_absent

Basisphenoid\_B (77): present --> paired\_pits\_on\_ventral\_surface\_absent

Shape\_of\_costal\_3 (225):

costal\_3\_tapering\_towards\_the\_lateral\_side\_of\_the\_shell\_or\_with\_parallel\_anterior\_and\_posterior\_borders -->

costal\_3\_broadens\_towards\_the\_lateral\_side\_of\_the\_shell

Costal\_rib (226): distal\_portion\_of\_costal\_ribs\_not\_visible\_within\_the\_costal -->

distal\_portion\_of\_costal\_rib\_visible\_on\_the\_surface\_of\_the\_costal

*Ordosemys leios* :

All trees:

Quadrata\_H\* (52): Processus\_trochlearis\_oticum\_formed\_by\_a\_great\_contribution\_of\_quadrata -->  
small\_contribution\_of\_the\_quadrata

Costal\_rib\_distal\_end (229): costo-  
peripheral\_fontanelles\_absent\_distal\_end\_of\_posterior\_dorsal\_ribs\_visible\_or\_distal\_end\_of\_posterior\_costals\_narrow\_and\_surrounded\_by\_the\_peripheral --> distal\_end\_of\_dorsal\_rib\_not\_visible\_or\_only\_within\_costo-  
peripheral\_fontanelles\_on\_the\_dorsal\_face\_of\_the\_carapace

*Sinemys brevispinus* :

Some trees:

Humerus\_B\* (200): shoulder\_present --> shoulder\_absent: pleurodires

Posterior\_plastral\_fontanelle (222):

posterior\_plastral\_fontanelle\_between\_the\_xiphiplastra\_and/or\_the\_hypoplastra: absent\_in\_adult\_stage -->  
retained\_in\_adults

*Sinemys lens* :

All trees:

No autapomorphies:

*Sinemys gamera* :

All trees:

No autapomorphies:

*Liaochelys jianchangensis* :

All trees:

Costal\_B (121): medial\_contact\_of\_posterior\_costals\_absent -->  
medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present

Shape\_of\_costal\_3 (225):

costal\_3\_tapering\_towards\_the\_lateral\_side\_of\_the\_shell\_or\_with\_parallel\_anterior\_and\_posterior\_borders -->

costal\_3\_broadens\_towards\_the\_lateral\_side\_of\_the\_shell

Costal\_rib (226): distal\_portion\_of\_costal\_ribs\_not\_visible\_within\_the\_costal -->

distal\_portion\_of\_costal\_rib\_visible\_on\_the\_surface\_of\_the\_costal

*Manchurochelys manchoukuoensis* :

All trees:

Nuchal\_emargination (230): present\_excludes\_peripheral\_1 --> absent\_or\_indistinct

*Basilochelys macrobios* :

All trees:

No autapomorphies:

*Siamochelys peninsularis* :

All trees:

Carapace\_D\* (111): Sculpturing\_of\_the\_shell\_absent --> present

Hypoplastron\_B\* (145): Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1 --> terminates\_on\_peripheral\_3

Hypoplastron\_B\* (148): Inguinal\_buttress\_terminates\_on\_peripheral\_8 --> 7

*Xiaochelys ningchengensis* :

All trees:

No autapomorphies:

*Kallokibotion bajazidi* :

All trees:

Prefrontal\_D (6): reduced --> prefrontal\_exposure\_large

Premaxilla\_A (31): united --> external\_nares\_divided

Vomer\_B (41): vomer-ptyergoid\_contact\_in\_palatal\_view\_present --> absent, medial\_contact\_of\_palatines\_present  
Prootic\_A\* (71): dorsal\_exposure\_large --> dorsal\_exposure\_reduced\_or\_absent  
Vertebral\_C (129): on\_neural\_V --> sulcus\_between\_V\_3\_and\_4\_on\_neural\_VI  
Extragular\_B (155): medial\_contact\_of\_extragulars\_absent --> present, contacting\_one\_another\_anterior\_to\_gulars  
Humerus\_E\* (203): length\_of\_the\_humerus\_more\_than\_two\_times\_the\_width\_of\_the\_proximal\_end -->  
length\_of\_the\_humerus\_two\_times\_or\_less\_than\_the\_width\_of\_the\_proximal\_end

Mongolochelys\_efremovi :

All trees:

Squamosal\_B (25): squamosal-supraoccipital\_contact\_absent --> present  
Squamosal\_C\* (26): posterolateral\_protuberances\_developing\_horns\_absent --> small\_protuberances  
Maxilla\_D\*\_ (38): labial\_and\_lingual\_ridge\_present --> labial, lingual\_and\_accessory\_ridges\_present  
Prootic\_A\* (71): dorsal\_exposure\_large --> dorsal\_exposure\_reduced\_or\_absent  
Cranial\_scute\_J\* (98): A\_scute\_small\_and\_not\_forming\_a\_large\_shelf\_no --> yes

Some trees:

Neural\_B\* (117): regular, often\_hexagonal, longer\_than\_wide --> irregular\_in\_shape, wider\_than\_long  
Caudal\_B (189): all\_centra\_amphicoelous --> formed\_centra

Sichuanchelys\_palatodentata :

Some trees:

Prefrontal\_E (7): absent --> prefrontal\_heavily\_sculptured\_present  
Pterygoid\_A (55): absent --> pterygoid\_teeth\_present  
Fenestra\_perilymphatica\_A (88): large --> relatively\_small  
Cranial\_scute\_F\* (94): low --> D\_scute\_high  
Caudal\_B (189): all\_centra\_amphicoelous, or formed\_centra --> all\_centra\_amphicoelous  
Humerus\_A\* (199): Ectepicondylar\_foramen\_in\_a\_channel --> only\_a\_groove  
Pterygoid\_extension (236): pterygoid\_extending\_to\_posterior\_end\_of\_skull\_and\_covering\_prootic -->  
\_pterygoid\_not\_extending\_to\_posterior\_end\_of\_skull\_and\_covering\_prootic

Sichuanchelys\_chowi :

All trees:

Plastron\_B (132): present --> central\_plastral\_fontanella\_absent

Some trees:

Suprapygial\_A\* (124): two\_elements --> more\_than\_2\_elements

Helochelydra\_nopcsai :

All trees:

Quadratojugal\_B (22): quadratojugal-maxilla\_contact\_absent --> present  
Supraoccipital\_B (67): large\_supraoccipital\_exposure\_to\_dorsal\_skull\_roof\_absent --> present

Naomichelys\_speciosa :

All trees:

No autapomorphies:

Spoochelys\_ormondea :

Some trees:

Pterygoid\_C (57): reduced\_to\_a\_paired\_foramen\_caroticum\_laterale --> triangular\_in\_shape  
Cranial\_scute\_K\* (99): A\_scute\_comparable\_in\_size\_to\_B\_scute --> A\_scute\_small\_A\_scute\_very\_large  
Supramarginal\_A (126): absent --> complete\_row\_present, or partial\_row\_present  
Cervical vertebra\_A (169): position\_of\_transverse\_processes\_middle\_of\_the Centrum, or anterior\_end\_of\_the\_Centrum  
--> position\_of\_transverse\_processes\_middle\_of\_the\_Centrum  
Pterygoid\_extension (236): pterygoid\_extending\_to\_posterior\_end\_of\_skull\_and\_covering\_prootic -->  
\_pterygoid\_not\_extending\_to\_posterior\_end\_of\_skull\_and\_covering\_prootic

Node 119 :

All trees:

No synapomorphies

Node 120 :

All trees:

Basioccipital\_A (70): tubercle\_absent --> with\_two\_or\_one\_ventral\_basioccipital\_tubercle  
Pubis\_B\* (207): cartilaginous\_or\_absent --> Epipubis\_process\_osseous\_or\_calcified  
Hypoischium\_A (214): absent --> present  
Carotid\_canal\_split (237): enclosed\_but\_carotid\_canal\_is\_not\_covered\_ventrally\_from\_posterior\_edge\_of\_skull, or 3 --  
> not\_enclosed\_in\_bone

Node 121 :

All trees:

Teeth\_A (105): teeth\_present\_in\_premaxilla\_maxilla\_and\_dentary -->  
teeth\_absent\_in\_premaxilla\_maxilla\_and\_dentary  
Carapace\_C (110): absent --> present

Node 122 :

All trees:

Ilium\_A (208): elongated\_iliac\_neck\_absent --> present

Node 123 :

All trees:

Jugal\_A (19): jugal-squamosal\_contact\_present --> absent  
Vomer\_C (42): vomerine\_and\_palatine\_teeth\_present --> absent  
Quadrate\_A (46): flooring\_of\_the\_cranioquadrate\_space\_absent --> by\_pt\_but\_pt\_does\_not\_cover\_the\_prootic  
Quadrate\_B+\_C (47): development\_of\_the\_c.t.\_shallow\_but\_not\_developed\_antpost -->  
shallow\_but\_anteroposteriorly\_developed  
Pterygoid\_B (56): basipt\_process\_present\_and\_movable\_articulation -->  
basipt\_process\_present\_and\_sutured\_articulation  
Opisthotic\_A (72): loosely\_articulated --> tightly\_sutured  
Opisthotic\_C (74): ventral\_ridge\_on\_opisthotic\_absent --> present\_with\_an\_incipient\_enclosed\_middle\_ear\_region  
Some trees:  
Pterygoid\_A (55): pterygoid\_teeth\_present --> absent

Node 124 :

All trees:

Parietal\_D (14): overhanging\_process\_of\_the\_skull\_roof\_absent --> present  
Opisthotic\_B (73): depressions\_for\_musculature\_absent --> present

Node 125 :

All trees:

Supramarginal\_A (126): partial\_row\_present --> absent  
Extragular\_C (156): anterior\_plastral\_tuberosities\_present --> absent

Some trees:

Musk\_ducts\_A\* (119): absent --> present  
Plastron\_A (131): connection\_between\_carapace\_and\_plastron\_osseous --> ligamentous  
Cleithrum\_A (197): present\_and\_in\_contact\_with\_the\_carapace --> present\_osseous\_contact\_with\_carapace\_absent

Node 126 :

All trees:

Squamosal\_C\* (26): small\_protuberances --> big\_protuberances\_developed\_as\_horns  
Pterygoid\_D (58): pterygoid-basioccipital\_contact\_absent --> present  
Cranial\_scute\_O\* (103): Scale\_F\_formed\_by\_several\_scales --> Scale\_F\_formed\_by\_only\_one\_scale

Some trees:

Pterygoid\_C (57): reduced\_to\_a\_paired\_foramen\_caroticum\_laterale --> reduced\_to\_an\_interpterygoid\_slit

Node 127 :

All trees:

Pterygoid\_B (56): basipt\_process\_present\_and\_sutured\_articulation --> basipt\_process\_absent\_and\_sutured\_articulation

Some trees:

Squamosal\_C\* (26): posterolateral\_protuberances\_developing\_horns\_absent --> small\_protuberances  
Supraoccipital\_A (66): crista\_occipitalis\_poorly\_developed -->  
protruding\_significantly\_posterior\_to\_the\_foramen\_magnum  
Hyomandibular\_nerve\_A (79): :\_path\_of\_hyomandibular\_branch\_facial\_nerve\_through\_cranio-  
quadrate\_space\_parallel\_to\_vena\_capitis\_lateralis --> independent\_to\_vena\_capitis\_lateralis

Node 128 :

All trees:

Maxilla\_D\*\_ (38): labial\_and\_lingual\_ridge\_present --> labial\_lingual\_and\_accesory\_ridges\_present  
Cranial\_scute\_B\* (90): Scute\_D\_meeting\_in\_midline\_no --> yes  
Cranial\_scale\_P\* (104): Scale\_J\_formed\_by\_several\_scales --> Scale\_J\_formed\_by\_only\_one\_scale

Node 129 :

All trees:

Cranial\_scute\_J\* (98): A\_scute\_small\_and\_not\_forming\_a\_large\_shelf\_no --> yes

Node 130 :

All trees:

Hypoplastron\_B\* (148): Inguinal\_buttress\_terminates\_on\_peripheral\_8 --> 7  
Ilium\_C (210): oval --> shape\_of\_articular\_site\_narrow\_and\_pointed\_posteriorly

Node 131 :

All trees:

Neural\_B\* (117): regular, often\_hexagonal, longer\_than\_wide --> irregular\_in\_shape, wider\_than\_long

Vertebral\_C (129): on\_neural\_V --> sulcus\_between\_V\_3\_and\_4\_on\_neural\_VI

Posterior\_plastral\_fontanelle (222):

posterior\_plastral\_fontanelle\_between\_the\_xiphiplastra\_and/or\_the\_hypoplastra: \_\_absent\_in\_adult\_stage --> retained\_in\_adults

Some trees:

Plastron\_A (131): ligamentous --> connection\_between\_carapace\_and\_plastron\_osseous

Node 132 :

All trees:

Quadrata\_A (46): by\_pt --> by\_qu\_and\_pro

Quadrata\_G (51): present --> processus\_trochlearis\_oticum\_absent

Pterygoid\_D (58): present --> pterygoid-basioccipital\_contact\_absent

Opisthotic\_C (74): present, with\_an\_incipient\_enclosed\_middle\_ear\_region --> ventral\_ridge\_on\_opisthotic\_absent

Xiphiplastron\_A (149): distinct\_anal\_notch\_absent --> present

Gular\_A (153): one\_pair --> only\_one\_scute

Inframarginal\_A (165): present --> absent

Cervical\_articulation\_A (172): not\_formed --> formed

Pelvis\_A (204): pelvis-shell\_attachment\_by\_ligaments --> ischium\_attached\_to\_plastron\_by\_a\_broad\_suture

Pterygoid\_extension (236): pterygoid\_extending\_to\_posterior\_end\_of\_skull\_and\_covering\_prootic -->

pterygoid\_not\_extending\_to\_posterior\_end\_of\_skull\_and\_covering\_prootic

Node 133 :

All trees:

Parietal\_H\* (18): absent\_or\_weak, foramen\_stapedio-temporale\_concealed\_in\_dorsal\_view --> moderate, f.s.t. but\_not\_entire\_processes\_trochlearis\_exposed\_in\_dorsal\_view

Basioccipital\_A (70): with\_two\_or\_one\_ventral\_basioccipital\_tubercle --> tubercle\_absent

Cervical\_rib\_A (168): present --> absent

Caudal\_C\* (190): anterior\_caudal\_vertebrae\_opisthocelous --> anterior\_caudal\_vertebrae\_procoelous\_or\_platycoelous

Pubis\_B\* (207): Epipubis\_process\_osseous\_or\_calcified --> cartilaginous\_or\_absent

Tail\_length (231): tail\_as\_long\_as\_carapace --> tail\_clearly\_shorter\_than\_carapace

Node 134 :

All trees:

Pterygoid\_B (56): basipt\_process\_present\_and\_sutured\_articulation --> basipt\_process\_absent\_and\_sutured\_articulation

Nuchal\_A (113): cervical\_articulates\_with\_nuchal\_along\_a\_blunt\_facet --> articulation\_absent

Scapula\_A\* (198): lamina\_between\_the\_dorsal\_process\_of\_the\_scapula\_and\_the\_acromion\_reduced: Kallokibotton --> lamina\_between\_the\_dorsal\_process\_of\_the\_scapula\_and\_the\_acromion\_absent

Node 135 :

All trees:

Cervical\_articulation\_A (172): formed --> not\_formed

Nuchal\_emargination (230): absent\_or\_indistinct, or present, excludes\_peripheral\_1, or deep\_and\_involves\_peripheral\_1 --> absent\_or\_indistinct, or present, excludes\_peripheral\_1

Node 136 :

All trees:

Cranial\_scutes\_A\* (89): present --> absent

Carapace\_E\* (112): like\_in\_trionychians --> Sculpturing\_of\_the\_shell\_like\_in\_Hydromedusa

Cervical\_vertebra\_F\* (175): 4th --> 5th

Node 137 :

All trees:

Stapedial\_artery\_C\* (82): Foramen\_stapedio-temporalis\_located\_in\_the\_dorsal\_part\_of\_the\_otic\_region\_and\_points\_dorsally --> located\_in\_the\_anterior\_wall\_of\_the\_otic\_region\_and\_points\_anteriorly

Costal\_B (121): medial\_contact\_of\_posterior\_costals\_absent -->

medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present

Vertebral\_B (128): vertebral\_II-IV\_broader\_than\_pleurals --> vertebrals\_II-IV\_narrower\_or\_as\_narrow\_as\_pleurals

Some trees:

Nuchal\_C\* (115): wider\_than\_long --> longer\_than\_wide\_or\_as\_long\_as\_wide

Node 138 :

All trees:

- Parietal\_H\* (18): strong, entire processus trochlearis exposed in dorsal view --> absent\_or\_weak\_foramen\_stapedio-temporale\_concealed\_in\_dorsal\_view
- Supraoccipital\_A (66): crista occipitalis poorly developed --> protruding\_significantly\_posterior\_to\_the\_foramen\_magnum
- Dentary\_A (107): sutured\_only --> medial\_contact\_of\_dentaries\_fused
- Cervical\_A (125): one\_cervical\_present --> cervicals\_absent\_carapacial\_scutes\_otherwise\_present
- Hyoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1

Node 139 :

All trees:

- Costal\_A (120): medial\_contact\_of\_costal\_I\_absent --> present
- Costal\_B (121): medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present --> medial\_contact\_of\_all\_costals\_present

Node 140 :

All trees:

- Musk\_ducts\_A\* (119): absent --> present
- Mesoplastron\_A (146): 1\_reduced\_pair --> absent

Some trees:

- Plastron\_A (131): ligamentous --> connection\_between\_carapace\_and\_plastron\_osseous

Node 141 :

All trees:

- Frontal\_B\* (10): not\_fused --> fused
- Parietal\_A (11): parietal-squamosal\_contact\_present --> absent
- Quadrate\_I\* (53): Quadrate-basisphenoid\_contact\_absent --> present
- Hypoplastron\_A (147): peripheral\_and\_costal\_V --> inguinal\_buttresses\_contact\_peripherals\_only
- Extragular\_B (155): medial\_contact\_of\_extragulars\_absent --> present, contacting\_one\_another\_anterior\_to\_gulars
- Humerus\_B\* (200): shoulder\_present --> shoulder\_absent: pleurodires

Node 142 :

All trees:

- No synapomorphies

Node 143 :

All trees:

- Nasal\_A (0): present --> absent
- Prefrontal\_A (3): medial\_contact\_on\_dorsal\_skull\_roof\_absent --> medial\_contact\_on\_dorsal\_skull\_roof\_present
- Prefrontal\_D (6): reduced --> prefrontal\_exposure\_large
- Parietal\_A (11): parietal-squamosal\_contact\_present --> absent
- Vomer\_B (41): vomer-pterygoid\_contact\_in\_palatal\_view\_present --> absent, medial\_contact\_of\_palatines\_present
- Quadrate\_D (48): precolumellar\_fossa\_absent --> large\_and\_deep
- Cervical\_A (125): one\_cervical\_present --> cervicals\_absent\_carapacial\_scutes\_otherwise\_present
- Cervical\_vertebra\_F\* (175): 4th --> Biconvex\_cervical\_vertebra\_in\_the\_middle\_of\_the\_neck\_2nd

Node 144 :

All trees:

- Parietal\_H\* (18): strong, entire processus trochlearis exposed in dorsal view --> absent\_or\_weak\_foramen\_stapedio-temporale\_concealed\_in\_dorsal\_view
- Pterygoid\_K\* (65): Fossa\_podocnemidoidea\_absent --> present
- Humeral\_B\* (160): Humero-pectoral\_sulcus\_only\_in\_the\_hyoplastra --> humero-pectoral\_sulcus\_crossing\_the\_entoplastron

Node 145 :

All trees:

- Maxilla\_D\* (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial, lingual\_and\_accesory\_ridges\_present
- Musk\_ducts\_A\* (119): absent --> present

Some trees:

- Plastron\_A (131): connection\_between\_carapace\_and\_plastron\_osseous, or ligamentous --> connection\_between\_carapace\_and\_plastron\_osseous
- Plastron\_B (132): present --> central\_plastral\_fontanella\_absent

Node 146 :

All trees:

- Cranial\_scutes\_A\* (89): present --> absent



Node 147 :

All trees:

Nasal\_B (1): nasals\_contact\_another\_medially\_along\_their\_entire\_length -->  
medial\_contact\_of\_nasals\_partially\_or\_fully\_hindered\_by\_long\_anterior\_fl

Pterygoid\_B (56): basipt\_process\_absent\_and\_sutured\_articulation --> basipt\_process\_present\_and\_sutured\_articulation

Pterygoid\_G (61): medial\_contact\_of\_pterygoids\_present --> absent

Node 148 :

All trees:

Parietal\_A (11): parietal-squamosal\_contact\_present --> absent

Node 149 :

All trees:

Parietal\_H\* (18): absent\_or\_weak\_foramen\_stapedio-temporale\_concealed\_in\_dorsal\_view -->  
moderate\_f.s.t\_but\_not\_entire\_processes\_trochlearis\_exposed\_in\_dorsal\_view

Epipterygoid\_A (54): present\_laminar --> absent

Basioccipital\_A (70): with\_two\_or\_one\_ventral\_basioccipital\_tubercle --> tubercle\_absent

Vertebral\_B (128): vertebral\_II-IV\_broader\_than\_pleurals --> vertebrae\_II-IV\_narrower\_or\_as\_narrow\_as\_pleurals

Some trees:

Dorsal\_rib\_A (184): length\_first\_thoracic\_rib\_long\_extends\_full\_length\_of\_first\_costal\_and\_may\_contact\_peripherals -->  
> intermediate\_in\_contact\_with\_axillary\_butresses

Node 150 :

All trees:

Prefrontal\_D (6): reduced --> absent\_or\_near\_absent

Extragular\_D\* (157): Only\_in\_the\_epiplastra --> Reach\_the\_entoplastron

Node 151 :

All trees:

Extragular\_B (155): medial\_contact\_of\_extragulars\_absent --> present\_contacting\_one\_another\_posterior\_to\_gulars

Node 152 :

All trees:

Cervical\_A (125): one\_cervical\_present --> more\_than\_one\_cervical\_present

Caudal\_B (189): all\_centra\_amphicoelous --> formed\_centra

Some trees:

Maxilla\_D\*\_ (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial\_and\_lingual\_ridge\_present

Node 153 :

All trees:

Prefrontal\_A (3): medial\_contact\_on\_dorsal\_skull\_roof\_absent --> medial\_contact\_on\_dorsal\_skull\_roof\_present

Prefrontal\_D (6): reduced --> prefrontal\_exposure\_large

Some trees:

Parietal\_C (13): elongated --> length\_of\_anterior\_extension\_of\_the\_lateral\_braincase\_wall\_inter

Supraoccipital\_A (66): crista\_occipitalis\_poorly\_developed -->  
protruding\_significantly\_posterior\_to\_the\_foramen\_magnum

Node 154 :

All trees:

Hyoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> Axillary\_buttruss\_terminates\_on\_peripheral\_2\_or\_1

Mesoplastron\_A (146): 1\_reduced\_pair --> absent

Carotid\_canal\_entry (235): fpcci\_is\_not\_at\_back\_of\_skull --> fpcci\_located\_at\_back\_of\_skull\_in\_pterygoid

Some trees:

Parietal\_E (15): processus\_inferior\_parietalis\_forming\_posterior\_margin\_for\_nerv\_trigemini\_absent --> ...\_present

Maxilla\_D\*\_ (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial\_and\_lingual\_ridge\_present

Pterygoid\_J\* (64): not\_reaching\_the\_exoccipitals --> reaching\_the\_exoccipitals

Nuchal\_emargination (230): absent\_or\_indistinct --> present\_excludes\_peripheral\_1

Node 155 :

Some trees:

Parietal\_E (15): ...\_present --> processus\_inferior\_parietalis\_forming\_posterior\_margin\_for\_nerv\_trigemini\_absent

Maxilla\_D\*\_ (38): labial\_and\_lingual\_ridge\_present --> Triturating\_surface\_with\_only\_labial\_ridge\_present

Opisthotic\_C (74): present\_with\_an\_incipient\_enclosed\_middle\_ear\_region -->  
present\_but\_modified\_with\_a\_enclosed\_middle\_ear\_region

Hyoplastron\_A (143): peripherals\_and\_first\_costal --> axillary\_buttrusses\_contact\_peripherals\_only

Hyoplastron\_A (147): peripheral\_and\_costal\_V --> inguinal\_buttrusses\_contact\_peripherals\_only

Node 156 :

All trees:

Parietal\_H\* (18): strong, entire processus trochlearis exposed in dorsal view --> moderate, f.s.t. but not entire processes trochlearis exposed in dorsal view  
Squamosal\_E\* (28): Qu-Sq contact tightly sutured --> wide open  
Nuchal\_A (113): articulation absent --> cervical articulates with nuchal along a raised pedestal  
Costal\_C (122): absent, costals fully or almost fully ossified, fontanelles abs or red --> present  
Plastron\_B (132): central plastral fontanella absent --> present  
Xiphiplastron\_B (150): xiphiplastra narrow absent --> present  
Manus\_B (216): paddles absent --> short paddles present  
Nuchal emargination (230): absent or indistinct --> present, excludes peripheral\_1, or deep\_and\_involves\_peripheral\_1

Node 157 :

All trees:

Cruciform plastron (232): absent --> present

Node 158 :

All trees:

Hyoplastron\_B\* (145): Axillary buttress terminates on peripheral\_2\_or\_1 --> terminates on peripheral\_3  
Extragular\_A (154): present --> absent  
Humerus\_A\* (199): Ectepicondylar foramen in a channel --> only a groove

Node 159 :

All trees:

Nasal\_A (0): present --> absent  
Parietal\_A (11): parietal-squamosal contact present --> absent  
Pterygoid\_H (62): pterygoid contribution to foramen palatinum posterius present --> absent  
Hypoplastron\_B\* (148): Inguinal buttress terminates on peripheral\_8 --> 7  
Humeral\_B\* (160): Humero-pectoral sulcus only in the hyoplastra --> humero-pectoral sulcus crossing the entoplastron  
Cervical articulation\_J\* (178): double articulation between 6th and 7th absent --> present  
Cervical articulation\_L\* (180): double articulation between 7th and 8th absent --> present  
Dorsal\_rib\_A (184): length first thoracic rib long, extends full length of first costal and may contact peripherals --> intermediate to short  
Dorsal vertebra\_A (187): anterior articulation of first dorsal centrum faces at most slightly anteroventrally --> faces strongly anteroventrally  
Humerus\_D\* (202): lateral process seen in dorsal view --> lateral process not seen in dorsal view  
Nuchal emargination (230): present, excludes peripheral\_1 --> absent or indistinct  
Articulation of posterior cervical centra (233): circular or subcircular outline --> greatly flattened outline

Node 160 :

All trees:

Parietal\_H\* (18): moderate, f.s.t. but not entire processes trochlearis exposed in dorsal view --> strong, entire processus trochlearis exposed in dorsal view  
Vertebral\_B (128): vertebral II-IV broader than pleurals --> vertebrae II-IV narrower or as narrow as pleurals  
Cervical vertebra\_B (170): ventral keels absent or slightly developed in all vertebrae --> ventral keels more developed on posterior vertebrae  
Cervical articulation\_A (172): not formed --> formed  
Some trees:  
Parietal\_C (13): length of anterior extension of the lateral braincase wall inter --> elongated  
Plastron\_B (132): present --> central plastral fontanella absent

Node 161 :

All trees:

Premaxilla\_C (33): foramen praepalatinum present --> absent, premaxillae well-ossified  
Maxilla\_C\* (37):  
Secondary palate formed by premaxilla, maxilla, and vomer, palatines not contacting in midline absent --> formed by premaxilla, maxilla, and vomer, palatines not contacting in midline present  
Vomer\_D (43): vomer-premaxilla contact present --> absent

Node 162 :

All trees:

Parietal\_A (11): absent --> parietal-squamosal contact present  
Parietal\_H\* (18): moderate, f.s.t. but not entire processes trochlearis exposed in dorsal view --> absent or weak, foramen stapedio-temporale concealed in dorsal view  
Antrum postoticum\_A (49): fully developed --> incipient

Pterygoid\_F (60): foramen\_palatinum\_posterius\_present --> absent  
Basisphenoid\_A (76): rostrum\_basisphenoidale\_flat --> rod-like,\_thick,\_and\_rounded  
Manus\_B (216): short\_paddles\_present --> elongate\_paddles\_present

Node 163 :

All trees:

Carapace\_A (108): carapacial\_scutes\_present --> partially\_present

Plastral\_scutes\_A (151): present --> absent

Cervical vertebra\_H\* (181):

total\_height\_of\_centra\_and\_neural\_arch\_much\_shorter\_than\_the\_anteroposterior\_length\_of\_the\_cervical\_centra -->  
total\_height\_of\_centra\_and\_neural\_arch\_longer\_than\_the\_anteroposterior\_length\_of\_the\_cervical\_centra\_

Node 164 :

All trees:

Premaxilla\_E (35): distinct\_medial\_premaxillary\_hook\_along\_the\_labial\_margin\_absent --> present

Some trees:

Plastron\_B (132): central\_plastral\_fontanella\_absent --> present

Posterior\_plastral\_fontanelle (222):

posterior\_plastral\_fontanella\_between\_the\_xiphiplastra\_and/or\_the\_hypoplastra:\_absent\_in\_adult\_stage -->  
retained\_in\_adults

Node 165 :

All trees:

Frontal\_A (9): present --> frontal\_contribution\_to\_orbit\_absent

Quadrata\_F: incisura\_columella\_auris (50): present,\_but\_qu\_and\_the\_op\_for\_an\_angle\_less\_90\_degrees\_in\_lat\_view --  
> present\_and\_closed,\_but\_only\_enclosing\_the\_stapes

Anal\_A (164): only\_cover\_parts\_of\_the\_xiphiplastra --> anteromedially\_overlap\_onto\_hypoplastra

Node 166 :

Some trees:

Abdominal\_A (163): present,\_with\_medial\_contact --> present,\_medial\_contact\_absent

Node 167 :

All trees:

No synapomorphies

Node 168 :

All trees:

Xiphiplastron\_A (149): distinct\_anal\_notch\_absent --> present

Cervical vertebra\_G\* (176): Biconcave\_cervical vertebra\_absent --> present

Node 169 :

All trees:

Plastron\_A (131): ligamentous --> connection\_between\_carapace\_and\_plastron\_osseous

Hypoplastron\_A (143): axillary\_buttresses\_contact\_peripherals\_only --> peripherals\_and\_first\_costal

Hypoplastron\_A (147): inguinal\_buttresses\_contact\_peripherals\_only --> peripheral\_and\_costal\_V

Hypoplastron\_B\* (148): 7 --> Inguinal\_buttress\_terminates\_on\_peripheral\_8

Node 170 :

All trees:

Pterygoid\_J\* (64): reaching\_the\_exoccipitals --> not\_reaching\_the\_exoccipitals

Suprapygial\_A\* (124): two\_elements --> one\_element

Node 171 :

All trees:

Costal\_D\* (123): absence\_of\_alternative\_short\_and\_long\_ends\_in\_the\_lateral\_part\_of\_the\_costals --> presence

Hypoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1

Pes\_C\* (220): 5\_digits --> 4\_digits

Node 172 :

All trees:

Humeral\_B\* (160): humero-pectoral\_sulcus\_crossing\_the\_entoplastron --> Humero-  
pectoral\_sulcus\_only\_in\_the\_hyoplastra

Manus\_A (215): most\_digits\_with\_three\_elongate\_phalanges --> most\_digits\_with\_two\_shortened\_phalanges

Node 173 :

All trees:

Pectoral\_B\* (162): antero-posteriorly\_developed --> very\_short\_antero-posteriorly

Node 174 :

All trees:

Plastron\_A (131): ligamentous --> connection\_between\_carapace\_and\_plastron\_osseous  
Hyoplastron\_A (143): axillary\_buttresses\_contact\_peripherals\_only --> peripherals\_and\_first\_costal  
Hypoplastron\_A (147): inguinal\_buttresses\_contact\_peripherals\_only --> peripheral\_and\_costal\_V  
Inframarginal\_B\* (166): 3\_or\_more --> 2

Node 175 :

All trees:

No synapomorphies

Node 176 :

All trees:

Cervical\_A (125): one\_cervical\_present --> cervicals\_absent,carapacial\_scutes\_otherwise\_present

Node 177 :

All trees:

Squamosal\_A (24): squamosal-postorbital\_contact\_present --> absent  
Maxilla\_D\*\_ (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial,lingual\_and\_accesory\_ridges\_present  
Inframarginal\_B\* (166): 3\_or\_more --> 2  
Cervical\_articulation\_I\* (177): double\_articulation\_between\_5th\_and\_6th\_absent --> present

Node 178 :

All trees:

Squamosal\_A (24): squamosal-postorbital\_contact\_present --> absent  
Palatine\_A (45): palatine\_contribution\_to\_anterior\_extension\_of\_lat\_braincase\_absent --> present,well-developed  
Carapace\_B (109): tricarinate\_carapace\_absent --> present,but\_only\_slightly

Node 179 :

All trees:

Maxilla\_D\*\_ (38): Triturating\_surface\_with\_only\_labial\_ridge\_present --> labial,lingual\_and\_accesory\_ridges\_present  
Stapedial\_artery\_B (81): significantly\_reduced\_in\_size --> absent  
Hyoplastron\_A (143): axillary\_buttresses\_contact\_peripherals\_only --> peripherals\_and\_first\_costal

Some trees:

Nuchal\_B (114): present,process\_crosses\_peripheral\_I\_to\_contact\_pe\_II -->  
elongate\_costiform\_process\_of\_nuchal\_absent  
Abdominal\_A (163): present,medial\_contact\_absent --> present,with\_medial\_contact

Node 180 :

All trees:

Plastron\_A (131): ligamentous --> connection\_between\_carapace\_and\_plastron\_osseous  
Cruciform\_plastron (232): present --> absent

Some trees:

Stapedial\_artery\_B (81): relatively\_large --> significantly\_reduced\_in\_size

Node 181 :

All trees:

Peripheral\_A (118): 11\_pairs --> 10\_pairs  
Hyoplastron\_B\* (145): terminates\_on\_peripheral\_3 --> terminates\_on\_peripheral\_4  
Abdominal\_A (163): present,medial\_contact\_absent --> absent  
Inframarginal\_B\* (166): 3\_or\_more --> 2

Some trees:

Frontal\_A (9): present --> frontal\_contribution\_to\_orbit\_absent  
Parietal\_F\* (16): not\_contribute\_to\_the\_processus\_trochlearis\_oticum -->  
contributes\_to\_the\_processus\_trochlearis\_oticum  
Quadratojugal\_B (22): quadratojugal-maxilla\_contact\_absent --> present  
Quadrate\_H\*\_ (52): Processus\_trochlearis\_oticum\_formed\_by\_a\_great\_contribution\_of\_quadrate -->  
small\_contribution\_of\_the\_quadrate  
Costal\_B (121): medial\_contact\_of\_posterior\_costals\_absent -->  
medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present  
Inframarginal\_C\* (167): axillar\_and\_inguinal\_not\_in\_contact --> axillar\_and\_inguinal\_in\_contact  
Dorsal\_rib\_B (185): contact\_dorsal\_rib\_9-10\_with\_costals\_present --> absent

Node 182 :

All trees:

Costal\_A (120): medial\_contact\_of\_costal\_I\_absent --> present  
Entoplastron\_E (140): present --> absent  
Intergular\_A (158): absent --> present  
Humeral\_A (159): 1\_pair --> 2\_pair\_subdivided\_by\_a\_plastral\_hinge

Node 183 :

All trees:

Nuchal\_C\* (115): wider\_than\_long --> longer\_than\_wide\_or\_as\_long\_as\_wide

Node 184 :

All trees:

Neural\_A (116): neural\_formula\_6>4<6<6<6<6\_absent --> present

Plastron\_A (131): ligamentous --> connection\_between\_carapace\_and\_plastron\_osseous

Carotid\_canal\_split (237): 3 -->

not\_enclosed\_but\_carotid\_canal\_is\_covered\_ventrally\_from\_the\_posterior\_end\_of\_the\_skull

Node 185 :

All trees:

Carapace\_D\_\* (111): Sculpturing\_of\_the\_shell\_absent --> present

Node 186 :

All trees:

Costal\_B (121): medial\_contact\_of\_posterior\_costals\_absent -->

medial\_contact\_of\_up\_to\_three\_posterior\_costals\_present

Suprapygal\_A\* (124): two\_elements --> one\_element

Node 187 :

All trees:

Peripheral\_gutter (228): peripheral\_gutter\_absent\_or\_only\_anteriorly\_developed -->

peripheral\_gutter\_extensively\_developed\_along\_anterior\_and\_bridge\_peripherals

Node 188 :

All trees:

No synapomorphies

Node 189 :

All trees:

Jugal\_B (20): jugal\_participation\_to\_upper\_temporal\_rim\_absent --> present

Carapace\_A (108): partially\_present --> absent

Peripheral\_A (118): 10\_pairs --> less\_than\_10\_pairs

Posterior\_plastral\_fontanelle (222):

posterior\_plastral\_fontanelle\_between\_the\_xiphiplastra\_and/or\_the\_hypoplastra:\_absent\_in\_adult\_stage --> retained\_in\_adults

Some trees:

Premaxilla\_D (34): exclusion\_of\_premaxilla\_from\_the\_apertura\_narium\_externa\_absent --> present

Maxilla\_A\* (36): do\_not\_contact\_each\_other\_in\_ventral\_view --> contacts\_each\_other\_in\_ventral\_view

Entoplastron\_D (139): entoplastron\_V-shaped\_absent --> present

Cervical\_articulation\_H (173): 8dorsal --> none,vertebrae\_only\_meet\_at\_zygapophyses

Humerus\_A\* (199): Ectepicondylar\_foramen\_in\_a\_channel --> only\_a\_groove

Humerus\_B\* (200): shoulder\_present --> shoulder\_absent:\_pleurodires

Manus\_and\_Pes\_B\* (221): Hyperphalangy\_manus\_digits\_4\_and\_5,\_pes\_digit\_4\_no --> yes

Node 190 :

All trees:

Prefrontal\_C (5): prefrontal-palatine\_contact\_present --> prefrontal-palatine\_contact\_absent

Premaxilla\_B (32): fusion\_of\_premaxilla\_absent --> present

Premaxilla\_C (33): foramen\_praepalatium\_present --> absent,\_foramen\_intermaxillaris\_present

Vomer\_B (41): vomer-ptyergoid\_contact\_in\_palatal\_view\_present --> absent,\_medial\_contact\_of\_palatines\_present

Vomer\_D (43): vomer-premaxilla\_contact\_present --> absent

Pterygoid\_G (61): medial\_contact\_of\_ptyergoids\_present --> absent

Carapace\_A (108): carapacial\_scutes\_present --> partially\_present

Peripheral\_A (118): 11\_pairs --> 10\_pairs

Plastral\_scutes\_A (151): present --> absent

Cervical vertebra\_B (170): ventral\_keels\_more\_developed\_on\_posterior\_vertebrae -->

ventral\_keels\_absent\_or\_slightly\_developed\_in\_all\_vertebrae

Pubis\_A\* (206): lateral\_process\_small,\_poorly\_developed,\_columnar --> lateral\_process\_well\_developed\_and\_flat

Manus\_C (217): flippers\_absent --> short\_flippers\_present, or elongate\_flippers\_present

Nuchal\_posterior\_edge (234): less\_than\_3\_times\_longer\_than\_the\_lateral\_edge --> more\_than\_3\_times\_longer  
Some trees:

Hyoplastron\_B\* (145): Axillary\_buttress\_terminates\_on\_peripheral\_2\_or\_1 --> terminates\_on\_peripheral\_4

Node 191 :

All trees:

Marginal\_A\* (130): marginal\_scales\_overlap\_onto\_costals\_absent --> present

Node 192 :

All trees:

Plastral\_scutes\_B (152): pronounced\_midline\_plastral\_sulcus\_sinuuous\_absent --> present

Node 193 :

All trees:

Pterygoid\_B (56): basipt\_process\_absent\_and\_sutured\_articulation --> basipt\_process\_present\_and\_sutured\_articulation

Basioccipital\_A (70): tubercle\_absent --> with\_two\_or\_one\_ventral\_basioccipital\_tubercle

Musk\_ducts\_A\* (119): absent --> present

Anal\_A (164): only\_cover\_parts\_of\_the\_xiphiplastra --> anteromedially\_overlap\_onto\_hyoplastra

Cervical\_rib\_A (168): absent --> present

Peripheral\_gutter (228): peripheral\_gutter\_absent\_or\_only\_anteriorly\_developed -->  
peripheral\_gutter\_extensively\_developed\_along\_anterior\_and\_bridge\_peripherals

Tail\_length (231): tail\_clearly\_shorter\_than\_carapace --> tail\_as\_long\_as\_carapace

Carotid\_canal\_split (237): 3 -->

not\_enclosed\_but\_carotid\_canal\_is\_covered\_ventrally\_from\_the\_posterior\_end\_of\_the\_skull

Node 194 :

All trees:

Nuchal\_emargination (230): present\_excludes\_peripheral\_1 --> absent\_or\_indistinct

Node 195 :

All trees:

Parietal\_H\* (18): strong\_entire\_processus\_trochlearis\_exposed\_in\_dorsal\_view -->  
moderate\_f.s.t\_but\_not\_entire\_processes\_trochlearis\_exposed\_in\_dorsal\_view

Node 196 :

All trees:

Basisphenoid\_B (77): paired\_pits\_on\_ventral\_surface\_absent --> present

Epiplastron\_A (141): epiplastra\_and\_entoplastron\_narrow\_and\_elongate\_absent --> present

Cruciform\_plastron (232): absent --> present

Node 197 :

All trees:

Cervical\_A (125): one\_cervical\_present --> cervicals\_absent\_carapacial\_scutes\_otherwise\_present

Neural\_number (223): less\_than\_9\_elements --> 9\_elements

First\_vertebral (227): vertebral\_1\_does\_not\_enter\_anterior\_margin\_of\_carapace --> enters\_anterior\_margin

Peripheral\_gutter (228): peripheral\_gutter\_extensively\_developed\_along\_anterior\_and\_bridge\_peripherals -->  
peripheral\_gutter\_absent\_or\_only\_anteriorly\_developed

Nuchal\_emargination (230): present\_excludes\_peripheral\_1 --> deep\_and\_involves\_peripheral\_1

Nuchal\_posterior\_edge (234): less\_than\_3\_times\_longer\_than\_the\_lateral\_edge --> more\_than\_3\_times\_longer

Node 198 :

All trees:

Cervical\_vertebra\_E\* (174): present --> Biconvex\_cervical\_vertebra\_in\_the\_middle\_of\_the\_neck\_absent

Node 199 :

All trees:

Plastron\_B (132): central\_plastral\_fontanella\_absent --> present

Node 200 :

All trees:

Costal\_rib\_distal\_end (229): distal\_end\_of\_dorsal\_rib\_not\_visible\_or\_only\_within\_costo-  
peripheral\_fontanelles\_on\_the\_dorsal\_face\_of\_the\_carapace --> costo-  
peripheral\_fontanelles\_absent\_distal\_end\_of\_posterior\_dorsal\_ribs\_visible\_or\_distal\_end\_of\_posterior\_costals\_narrow\_and  
surrounded\_by\_the\_peripheral

Node 201 :

All trees:

Vertebral\_B (128): vertebrals\_II-IV\_narrower\_or\_as\_narrow\_as\_pleurals --> vertebral\_II-IV\_broader\_than\_pleurals  
Posterior\_plastral\_fontanelle (222):  
posterior\_plastral\_fontanelle\_between\_the\_xiphiplastrum\_and/or\_the\_hypoplastra: \_\_absent\_in\_adult\_stage -->  
retained\_in\_adults

Node 202 :

All trees:

Pterygoid\_D (58): present --> pterygoid-basioccipital\_contact\_absent

Pterygoid\_J\* (64): reaching\_the\_exoccipitals --> not\_reaching\_the\_exoccipitals

Some trees:

Quadrate\_D (48): precolumellar\_fossa\_absent --> large\_and\_deep

Epiplastron\_A (141): present --> epiplastrum\_and\_entoplastron\_narrow\_and\_elongate\_absent

Node 203 :

All trees:

Epiplastron\_A (141): epiplastrum\_and\_entoplastron\_narrow\_and\_elongate\_absent --> present

Extragular\_B (155): medial\_contact\_of\_extragulars\_absent --> present, contacting\_one\_another\_anterior\_to\_gulars

Nuchal\_emargination (230): absent\_or\_indistinct, or present, excludes\_peripheral\_1, or  
deep\_and\_involves\_peripheral\_1 --> broad, involved\_peripheral\_II

Some trees:

Frontal\_A (9): present --> frontal\_contribution\_to\_orbit\_absent

Basisphenoid\_B (77): paired\_pits\_on\_ventral\_surface\_absent --> present

Cranial\_scute\_C\* (91): yes --> Scute\_X\_much\_smaller\_than\_D\_scute\_no

Antrum\_postoticum (238): region\_of\_antrum\_postoticum\_enlarged\_and\_laterally\_enclosed -->  
region\_of\_antrum\_postoticum\_enlarged, but\_not\_enclosed\_laterally

Jugal/quadrato\_contact (239): jugal\_clearly\_not\_in\_contact\_with\_quadrate -->

jugal\_nearly\_or\_clearly\_in\_contact\_with\_quadrate

Parabasisphenoid\_decorated\_by\_ridges (240): absent --> present

Node 204 :

All trees:

Opisthotic\_C (74): present, with\_an\_incipient\_enclosed\_middle\_ear\_region --> ventral\_ridge\_on\_opisthotic\_absent

Recessus\_scalae\_tympani\_A\* (83): well\_developed --> almost\_inexistent, not\_surrounded\_by\_bone

Carapace\_D\_\* (111): Sculpturing\_of\_the\_shell\_absent --> present

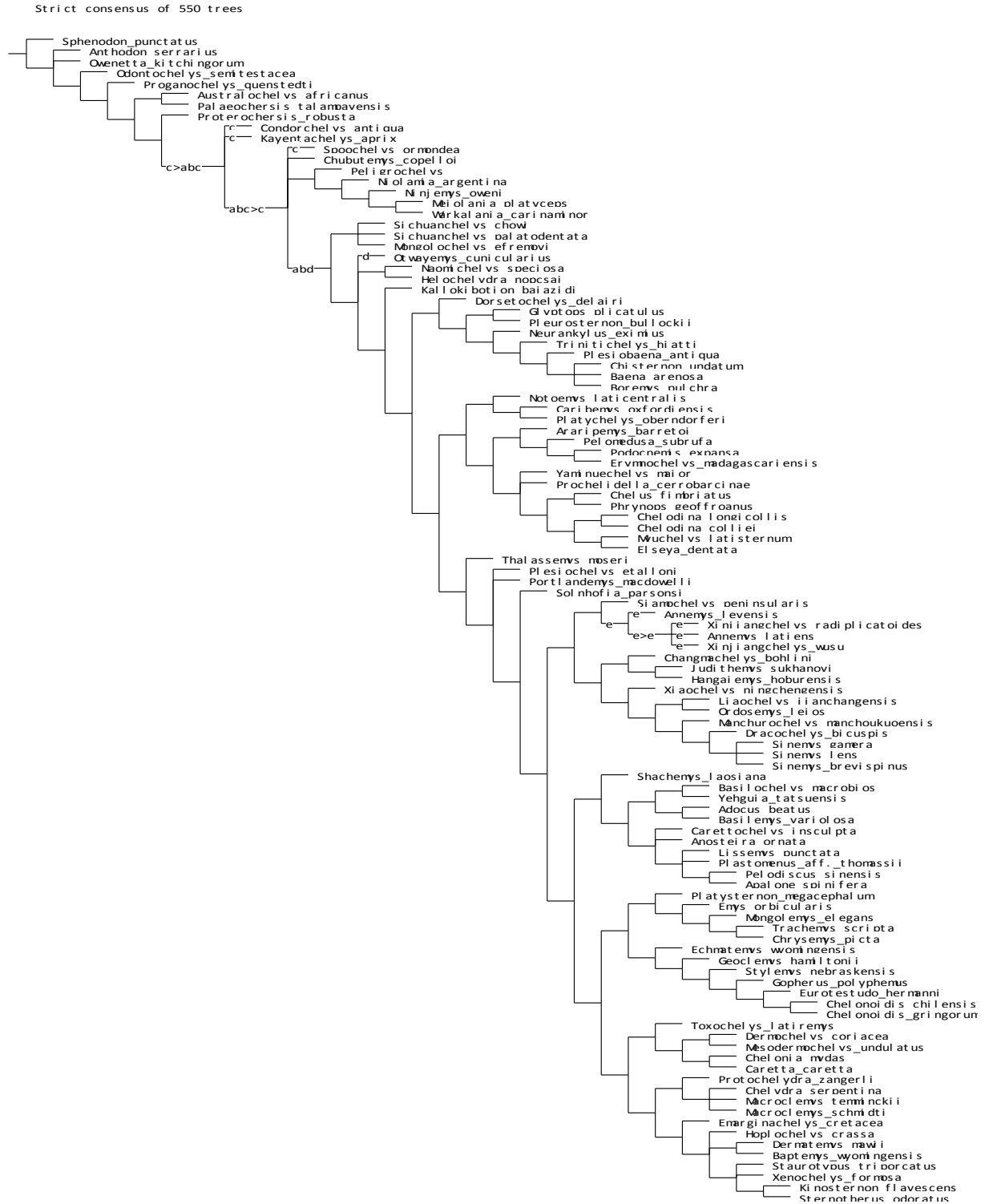
Entoplastral\_scute (241): absent --> present

Secondary\_pair\_of\_basioccipital\_tubercles\_formed\_by\_pterygoid (242): absent --> present

Shell\_covered\_by\_highly\_distinct\_tubercles (243): absent --> present

## C. Alternative positions of wildcard taxa

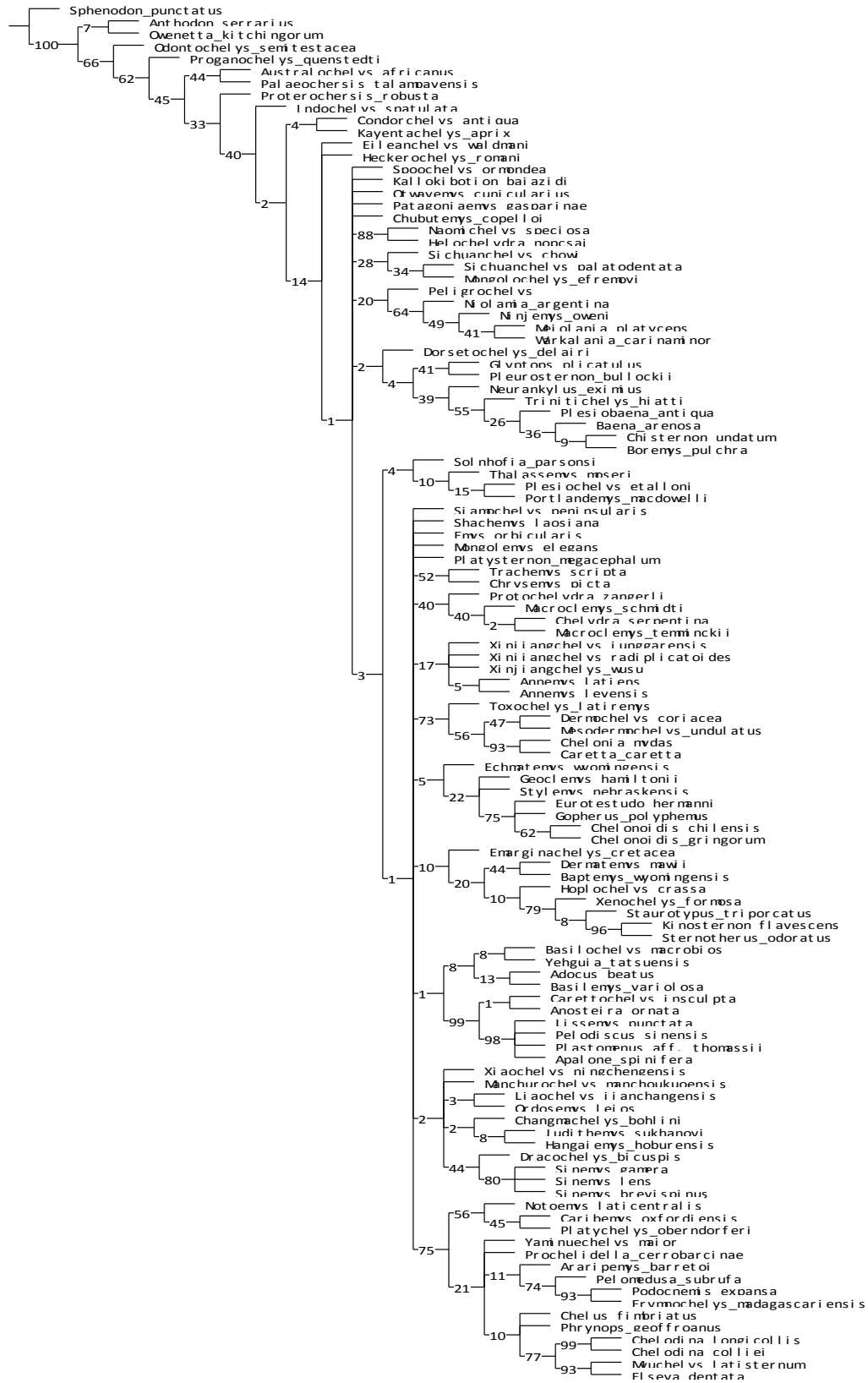
a: *Heckerochelys romani*, b: *Eileanchelys waldmani*, c: *Indochelys spatulata*, d: *Patagoniaemys gasparinae*, e: *Xinjiangchelys junggarensis*





# D. Frequency differences values of standard bootstrap resampling of 1000 replicates

GC values, 1000 replicates, cut=1 (tree 0) - Standard Bootstrap



## E. Frequency differences values of standard bootstrap resampling of 1000 replicates with 5 wild card taxa excluded

GC values, 1000 replicates, cut=1 (tree 0) - Standard Bootstrap

