**Appendix I. Data matrices for parsimony analyses.**

The following sections include data matrices used for parsimony analyses in TNT 1.5.

**1. First run of ‘unordered’ parsimony analysis (1stUOPA)**

xread

'Exported from NEXUS Data Editor'

270 99

Yunguisaurus\_liae

0001000??10000000??0010010?000010010?000?000110??200??00?????01020???????????????02?10???????0?0?0010020???10011001100?1001?1????13??0??????1??????????41000??00?000000?001??0??01210?0?00???0??????0?000?200????????????0?00122011?0000002000??11000?000?0?000000010000100000

Pistosaurus\_postcranium

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????20011100000000000110100101100010????101110?00?001?202100??0??001????0122210???1??????01?1?00000000???0???0?10????????0

Pistosaurus\_skull

010100?0010000000??001001000000?10000001000001001200?000????0010?0???????????????02??00000??0000?0010020????20?????????????????????0100??00???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Augustasaurus\_hagdorni

010100?0010?00000??00100100000000000000100?0010012101000010??????0???0?0000??????02??000?0110000?0010000????0?1100?10??1001??1???01010002100???00??21??41?01??000000200?0?10000011??0000???????????00?000?102?020000?0?????????????????000??00???100000000???0?100?1000???0?00

Bobosaurus\_forojuliensis

????????????????0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????02?0?00?00??01?2100000??110?12?000?00??001221100?10?1????????????????????????????????0122010?001??????0???1?000????????0???0?0??0??????

Macroplata\_tenuiceps

1101001??10?10101110??001??1001010?0???????0010????0?????????010100?012?100??01?100211???????????100??00??????1111??0??21???11??00201001110000100??210220001???110?120100??30?001?11100000?0110000?20110?1????0000000?001?0001?2012?002?????0?101?0?0?0?0?110?1???010??01?????

Anningasaura\_lymense

111000?0120?00??10000100?0010000100000?10000010112001000?10?0?1020?0110111010010?00211?1000000011?00?000?111??1110?100?1010?110??00010011000?0?00??0?0??10010??3?0?120100?031?1???????????????????????????????????????????????????????????????????????????????????????????????

Stratesaurus\_taylori

001000?0100100100??0110010000010?0?000010000010001001000010101101012002000010?00102211???01000010110?000000?2?111?11000110001?0?001000011000?0?00??2001?10010011100120100003101??1????00?0????????????1?????????????????????01022111??????????????????????????1???010??010??10

Avalonnectes\_arturi

??????????01??10????????10?????01??00001000001001100100001010???????????????????1??????0???????????????????????????????????????????????????????????????2100?00211001??100?0110001101101200?0110?00????1?01201???????????????0102?110??1?????????11020?000?110110?101000010?100

Eurycleidus\_arcuatus

???????????????????????????????????????????????????????????????????????????????????????????????????????????????111??????????1?????????01110?????????????100100211000201000010100?1?1101????0110100?201101120010201000100?10001020110001??????0101?02110010110????1?10????????0

Meyerasaurus\_victor

10?00?0?21??00??11??0100??0000???0??????????????????10?0??0101???0????????0??????022?0?1?01010111122?11000101?0111100?02110211???01?1001010?0???0???1?120?01?????00?20????0???0011211012002?110?0?0111?0?1????0201000?0001000102011?0011002100??12020?00021??11011010001101100

Maresaurus\_coccai

110100?1220?1???1120?1001?0?00?????????????00001120?10???10?0110?0?????0?????????0??11?000101010?122?1000???200111?00??2100?11???01?1?011100????0???????0001???2?0????1???030?????????????????????????????????????????????????????????????????????????????????????????????????

Borealonectes\_russelli

11010?1?210?102011100?00?0?0000??010?0010010000????1?000??0?0???20???12000???????022?1?0???????0??2???201?????111??00???1?0?110??0??1?01?10?00100??21?120001???2?0??20?????30?0????????1???????????????????????????????????????????????100??00?????1101012???2?011?0001???11?1

Atychodracon\_megacephalus

100101212201121010002100100100?000?000010000010012001000110101???0?201?000???0??1002111000100011011???00?0002001111?0??20?0?11??0??00001020?0???0???10120001???1100?201????10?00111?1012001??20?0?0??????????1??????????????01022110????????00??1?0201001?110?1??1010??0?????0

Archaeonectrus\_rostratus

1002002???0?102?1111??00?????????0?000?10000010012011000?1??01?????????????????????????????????????????????????11??1????1?????????????11120?0??????????2100100111000201???0?11?0110110110010??????0?????0?20?1??????????????01?2?1100?10001000??1?020?00??11011011010001101100

Rhomaleosaurus\_cramptoni

10000021220?1020100121101?00001?1000000???0001001201100011110?10?0???1?000???????02?1110?01010110122?1000000200?11?00??2100?11???01?1?01020?00?????????200???1211000??1?0?01?1?0002110?100?0????0?????1??????????????1??????0102?11000?10???00??1?021?001?1??110110100?11?1?00

Rhomaleosaurus\_zetlandicus

11000??1220?102010012110??00001??000???????001001?0110?0?1110110?????1?0?0????????2211??0?1????1?1?2??0??0??2001111000021002110000??1001020?0??????????200010??110?020100?010?00??2110?1???01201000????????????????????????????????????1?0??001212021000121101101101001?????0?

Rhomaleosaurus\_thorntoni

11??0???2?0?10??1021?1101?00?????0??0001000?????????????1?????????????????????????????1??01??01?????????????200111??10?11???11000?11100101000???????????0001???110?000100??10??01?21101?00?0110100??01100120210?0?000100?10001220110001??????0111?02100002110?????????????????

Thalassiodracon\_hawkinsii

00100001110100111120??0?1000???0000000?10020000001011000010110101010002000011000101011?00011001??100?000????0?11101100010000?1200?001001110010000??2101310010011100120100002100011101000001011000002011011001?00000001000?0001020111001000200000110100000010?11001010000101100

Hauffiosaurus\_longirostris

00?20??0?1??12111120??00???2????????????????????02???????????01001??0???1?0?????1110?????????????110?0??0?????1001?100?1100?11?0023010011200??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Hauffiosaurus\_tomistomimus

00020?10210?1?110??0100?0?0210100100???????00?00010100?0?101?01011??????1001????111011?0?0100010?100?010??????1000?100?1100?112002301001120?1100?????1231001?11110?100100002000011101010001??10???0???1??1?0?0????????????00????????00???0?1000012010000121?01101?1?0?11201?00

Hauffiosaurus\_zanoni

00?2??1??1??????????????0?0??????????0?10???????????00?001???010????????????????11101101?0100010?100?010????20100??100?1100??12002301?01120000?00??????310011?11100100100?020?00?????????0?01100000201101120??0020000?010?0001020?2?0001001000??11010?00121??11011010001101100

Marmornectes\_candrewi

0???????????00??0?????00???????????????????????0????10???0???0????????????????????????????????????????????????10100110?0000?111000201021020000000??21?1?0001???1200100100?200?1001??1?00?1?0010000??????1?0??000?00???00????00220111??2000??00110001000012100?1??1110??011???1

Peloneustes\_philarchus

10020120211100210??010001000101?010000010020010003121100010?00101100011000011?10102211100110?010?12110200???2110110110000001111000211001020001000??21?110001?121200110100000011001201100?1?0010001?00?1011000010000002000??1002301111022000?01??000210001220022101110111111111

Simolestes\_vorax

110101???21?10210??010001??010??0100000100200?0003111?000?0?0010110??11000????1???221110???????0?121?0210???210111??10?0000?111000??1?01010?0??00???111100011121?0?1000001200110????11?????0????0??20?10012010?02?000?0????000230??1102201??010100021010122001110111001111????

Pliosaurus\_funkei

???????0?????0????????????????????????????????????????????????2?2??????????????????????????????????????????????????01????00?1????0????010?11????????????0001???1????00???0?00?2?00??1100??????????????????????2000000200?????????????????0??0?0????2?01012???3?101?0101???1??1

Pliosaurus\_westburyensis

110101?0221110210??010011000011?1100000100200100231111000201002020???1????0????0?0121110011??????12110210???1?101?0010?200???13000?01011011?????????????0001???1?00?00?????00???00??1100??????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_carpenteri

11010????2??10210??0??011?00???????????????00?00231111???20?002020??????????????????11?00110?010??2110?1??????1011??10??0?0?1110002111010111???0????1?0?0001?0?1?0?1000000200120?0??110????????????1??1?0?2000?????0?2?0???????????????2????00????1???10?????3310?1?1011?11??1

Pliosaurus\_brachydeirus

11?1?????2??102?0??01001???0???????????????00?0???1??????????02020?????????????0?????????1?????0?12110310?????101??010?2000??13000?011010?1?0???????????0001???120??10???0?00?2010??1100????????????????????????????????????????????????0???00????0?????1?1??23???1?1??10????1

Pliosaurus\_macromerus

1101????22??10210??0??011?0????????????????00?0???1??????????0???0?????????????00022111001100010?12110310?????1011??10??000?11300010110101?1??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_brachyspondylus

???1?????????????????????????????????????????????????????????0????????????????????????????????????????????????1011?010??000?113000????01011?010?????1?010001???120??00?????01?20??20???????????????1??1??0???0???????200?????????????????????0110?02101012100????????????????1

Pliosaurus\_cf\_kevani

?????????????0???????????????????????????????????????????????????????????????????????????????????????????????????????????0????????????010?2?????????????0001???1?0??00???0?00?2?00??11??????????????0?1????????020000200???0002300111032????00??001?10101210023101101?11011211

Pliosaurus\_kevani

110101?022??10210??010011000011?1100?0010020010023021100020?00202000011010?0??10?022111001100010??????????????10??0010021001113?002111010?21??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Gallardosaurus\_iturraldei

??0?01?022?1??21????????10??????11?0000100200100?3121100020?011021???1????????????121110???0?010?12110310???211?????1???0?????????????????2????00??2111?00011??1?0?110?0??20??????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_rossicus

11?1?1??????10210??01001??????1?11000001??200?0??3111??????????????????????????????????????????????????????????1????????0?????????1?1?01011???????????????????????????????????????????????????????????1000200?2????0?2????????????????????????????????????????????????????????

Pliosaurus\_irgisensis

???????0??????21????????????????11?0000100200?0?231?11?002??0???2????1??????????????????????????????????????????????????????????????????????????????????000??1?1?0?1??000?200???????????????????????????????????????????????????????????001?0?????0???10??1???3???1????1?111??

Pliosaurus\_andrewsi

01020?2021??10210??0??00??00???????????????00?00?3?211?0??0?00??11??????????????102?11?00110?010?1211020????21111?0110000101111000211001010001001102??210001012110010000002001100120110??1?0010000??????????????????????????00230110???200??01??02021010122003210?100011011211

Liopleurodon\_ferox

11010120221110210??010001000101?11?0000100200000031211000?0100101100?1100001??101022111001101110?12110210???2111110010?0010?111000111101010001100??0110100011121200100101000011000?0110????2010100????1??0?000?????0??01???1????????10320???010???02101012?0?2?101?0001???1?11

Kronosaurus\_queenslandicus

??0?0?20?1??????0?????????????????????????????????????????01000???00011000?01110?111?0???????????12110?10??????????0????001????0??????01010?011?0??2??00000?11?3211?0?000?0001??0?20?1??0??2?10000?00?10?0?????02??0020????1????????103??????????????????????????????????1????

DORK\_G\_1\_2

?????????????0?????????????????????????????00100231210???20?0?????????????????????????????????????????????????????????????????????????110?0???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Megacephalosaurus\_eulerti

010200?0211100210??110000010210?111000010120010023121000120?00???????????????????011???00011000101211031010?2111000010?0001?1110000000110100???????????????????1??????????????????????????????????????????????????????????????????????????????????????????????????????????????

Brachauchenius\_lucasi

00020120211100210??010001000210?111?0001012001000312100012??00???????????????????011?0100?1011?0??2100310???211???001?00001?11?????????10?0?0???0?????000002????211?00?????????00??001???????????????????????????????????????????????????????????????????????????????????11111

Brachauchenius\_MNA\_V9433

0102?????1?100210??0100010?0????????0001???00?002?1210?0?20?0????0?????????????????????00????110??2110210???2111000010?0001?1110000000110100???????????0000211?3211100000?200?2?0???01??????????????0?1???????22200002?????11??0011?10????????????????????????????????????????

QM\_f51291

????01??2?????210??010?????0210?1110000????0010???12?????????????????????????????????0?00????????????????????????????????????????????????10???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Attenborosaurus\_conybeari

00010010???110??112???0010?0?????0??0001002??????2??10000???11??????????????????1?2???????????????????????????0110??0???0?????????10100???0?2??????????310??011110????1???0?00??11101100?0???1???1?20?10?1????0220000?000?310?02??1?0010001000??1??10?00?????1?001?100???01101

Plesiosaurus\_dolichodeirus

001100?0110?00100??0010010?000010010000100?001000100100001010110?010?02000?1111?10?01100?01000110100?000?1110?0100?100?1000???????100001110?2???0????01410010121?00100101003?00011111100001000010??211101100110000000?000?000002012100100020000?1102010000200110?1010000?01100

Eoplesiosaurus\_antiquior

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2??????????4100?0111?0?12?1???03??0??????????01000?11?02??1001002?0?0??00???????0??2?11?00110020000?11010100??1?0110?1010000101100

Eretmosaurus\_rugosus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100110?100?12010000?000111??11?0???0000?01????1?????????0??0???????0010201200011000000??11021?100020011011010000201100

Westphaliasaurus\_simonsensii

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2????????????0011021?0??0010?1031000111?1?0010?0000101?211100120??00000001??10000??20?20001?????00011002100011100110110100011?1??1

Seelyosaurus\_guilelmiimperatoris

00000?00?10?02?????0???????0?????0??0011001????1?1?01000?0??11?????????????????????????????????????????????????10??100?1010???????100001100?2??????????3100?1221000???1???00?00?1200110010?100001101101001201?10030?1?0???300?02??200011000100??11020?100?20011011000011201101

Microcleidus\_tournemirensis

0000000?120102100??0010010000000001011110010010002001000110?1????1?????000?????0112?110000??00?0?12100100???20????????????????????11000110012?????????142101112100?20?100?0010011200111010?????????201100120211013010?010?300122012000110????0??1?020?100?2?0110110100012?1??1

Microcleidus\_brachypterygius

0011000?110102100??0010010000000101011110010010102001000100?????1???????????????101??100?0010000?12100000???20?????????????????????0000110012?????????2321011121?00??1????00100?12011110?03100011?0210???1????20130?0?01???101220?10??01002000??11021?100?2??11010010011101101

Microcleidus\_homalospondylus

0000000011010210???0010020?000?010?0111100100101020010001??11110110010200001??001021?1?00????000??2100100???2001001??00?0???102???10000??0012??????????42101112100020110010010011201111010?1000011??1011110001?01?010101???00122012000010?20000011021?100110011011010011201101

Plesiopterys\_wildi

00100?0?1???00????????00???00??1?0?0???10??01?0001001000?00?0?10101110200001001010110???1????0011?00??00?100???20??100?1000?0?2??0?00?01110??????????02420011121101?001??0001001111?1100003000000?01?11?01201??0??0???010?3?0102012?001???00?000110200101?2??11001010011101110

Cryptoclidus\_eurymerus

00100?0010?101100??00100101000010000020100201001011010000000010?1011101101?111011111??00101100011?00?0????000?02001100?1000?0021?0200001110121111101?013100111232011001110000000111011000000010001121011001010201201020200?1100210110112010?101113032010122101300110?2??001211

Tricleidus\_seeleyi

01100???????011010?00?0010?000?100?????????01001?3001000?000010?00?0111111?????111110?????????011200?000?1100?0201110001000?0021?01110011001?11?1101?02210011123201100111000100?11?01100???????????110110000002012010202?13????????????210??1011130210101221023001101111101211

Muraenosaurus\_leedsii

00????????0?01100??001001??000?10??????????010?0?????1???0???10?00?0????11?????11011??????????????0???????????0201010002000?0021?010100110012?1?1101??14210112232012001110001001??11111000?200?111???????0???0?????1?2020?3?1012?021??12????1001230311101221023001100111001210

Kimmerosaurus\_langhami

??1??0?1??0?0????????????0?????10??0??????20100000102000000011101010201101?101111111?????????????200?0????????0200110001000?002??0?00?01220???1?1001?01?00011??3?01100111???1?0???????????????????????????????????????????????????????????????????????????????????????????????

Pantosaurus\_striatus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100111?320??00???000100??1??110000?2000111?????????????????????????01001?021011200??10????0210101??1?1?10???211???1211

Picrocleidus\_beloclis

?????????????????????????????????????????????????????0????0?010??0?????????????10012??????????????????????????????1100?1000???2??2?????11?????1?1101?02411011223201200111000100111?011?0?0?200?101001011002010201201020201?01?12?021112200??101???02111012210110010011111?1?10

Tatenectes\_laramiensis

???????0?????????????????0??????0??????1????????????2000?0000??????????????????????????????????11????????0?1???????????????????????????11??????01001????00011??32011001?1000100?110?110000??????????1011???????01??1020101?10?110021011210??10????0210101??1?2?001?0211??01??1

Plesiosaurus\_mansellii

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1111101??2?1101???320??00?????01?01??1111?????1010011??0???????????2??1?202????????????????????????????????????????????2?????????

Colymbosaurus\_trochanterius

???????????????????????????????????????????????????????????????????????????????????????????????????????????????????100?1000??????0????????????1?1110??2410012??320?200111??01?01??1011??00?2010101??0???????????2??102?2???????????????201??10111?2210101221022101102?11101211

Djupedallia\_engeri

??????0?????0?????????????????????????????????????????????00???????0?01111????????????????????????????????????020??????????????????00?0??1??2011???100?510012113201200111030100110??1100??????????????11?0???0?0??01??????3????????????2?0??????1?02?0?012?1???101102???1?1211

Spitrasaurus\_spp

??????0?????0?????????????????????????????????????????0???00??1010?????????????1??????????????????0???????????0201?100?1000???2??0?00?01110?20111111??2521012213201200111030100110?01100??????????????11?0???0?0??01???2???????????????2?11?????1?02?0?012?1???101102?1???1?11

Abyssosaurus\_nataliae

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???1110??1?1001???3201200111??01?01??1011??0???0???????0010000100??2??10?0?001?1?1101110??2?1??1????10???10?22?0?3??110???1001211

Umoonasaurus\_demoscyllus

00000100112??1101020??00??00????0??????????0?002222?10???10?11????1??12?11?0??0??022?????0?????11122?1211000????????0??1111???????1111010?01????????????1001????20?1??1010??00?110101102000201?00?1???1?01?010?????????????0???????????21????0111?02001022210?2???1?0??10?1??1

Nichollssaura\_borealis

0000010011200010102010001100000100?000010010000122301010010011??211?2??0???00000?0221110101100011122?13110000?0111110??0101?112??02?1001010100100??20022100100132011?010??000??1102?101?00000?????????10110020??????????????2?12102?01?2??0000??1??200101?21012101100011101110

Leptocleidus\_capensis

010001?1112?1010102002001?0000?10??0000??01001022?201010?0??01??21?????0?????????0221110?01?00011122?12110001?????1110?0111???2?111111010101???????????210010??320?1?0100?0?0?0?????1??????????????????????????????????????????????????2????00????0???????????2???1?0??10?1???

Leptocleidus\_superstes

??0?0??1?1?0????10??????1??????????????????0?10222201010?100011121?0011?01???????02211???????????122??31????1???????????????????????????????????????????0?01?0132011001000??00?110?11102???1011001?10110011020??1?100200102??????????????????01???02001012?0??????????????????

Vectocleidus\_pastorum

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?01??0?1??1010??00??10??1102?????????????1???1?02???1??01?10?0????????????????????????????????????????????????????

Brancasaurus\_brancai

0010?000100000??101002001?00000?0?1000???0101?02223010?0?00?011101101120101000100022?????011000???0???????????01???100?1110???2??121100111?120100??20014100100232012?0101100000110101102000101?1011???1?01?0201?10?0?210?0201012102101121????0111002001022200321?11???110?1???

Gronausaurus\_wegneri

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?12?20?2001111?000?1110011100002011101????1????????????0?210???01012102101021????0112?02000022210?1???1?0????????1

Speeton\_clay\_plesiosaurian

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???????????2101012320120011110010011201111000?20?1111??1011?1??20??1??002?????010121011011200??00102103001022?1021001100011101?11

Wapuskanectes\_betsynichollsae

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1??1??0???????????2101?2?110?1110110?10??3????????????200???01???03000022???????????????????0

Futabasaurus\_suzukii

00??000?1?0?00??0??00?0?2?0000????????????????????0???1??????????????????????????????????0110000???????????????100??????0?????????100001100???????????????11?22?2022001111?010?11110111000??????????????????????????????01301?1??01?0?1100200000220300102221122101100011101?10

Callawayasaurus\_colombiensis

000010?0?10000??10100?0020?000?10????????01010000220101010001111011??02?1010??1?002211001????0?0???2?1100???1?1101??0??20?????2??010000110012??????????5210102232022001111?0100111211110???????????200100?11001120010?10?01?????????00??0???100?220300102?3101200?10?0111??2?1

Eromangasaurus\_australis

000000???10000??10200?0020?000??00?000010??0010???????101?0?11????????????????????2????????????0???????????????1011?????010????????000011001?01?1101??2?2101???3?0??????????1?0???????????????????????????????????????????????????????????????????????????????????????????????

Kaiwhekea\_katiki

00001010??000???1020020020?000?????????11????0?0?32?2111000?00????????????????????????????????????????????????0101?10??1000??????0300001120?2??????????51011122320?2?0111?10100?11111?10???2????0??????????????????????????????????????000??00??11?32?11??3?12110100?0012?1??0

Aristonectes\_parvidens

00?010??1?0000201??00200200000??00?????11??01010?3212?1?0000?00?1?01212010???????????????0?10000??????????????0101010??1000???????3000011200?1101101?02?1111???3???200111??01?0???????????????????????????????????????????????????????????????????????????????????????????????

Libonectes\_morgani

010010?011000020102002002000000?00110001001110??0?21??111?00010?010?20201010?00100221100101?00?0?122?1200???2101000101?2000?112000101001?0012???1?????1621?122?320?200111??01??1???????????????????21011??????11100?0?100?1?????????????00??00????????10??????200??01?1???????

Hydrotherosaurus\_alexandrae

000010?0??0000201?100?002??0000?0011000100111?????2121?111??01?????????????????????????????????????????????????100010?1?01??112???10000110012???1?????1521112223202200111?101001110011100002011?11?1001?00001011200?020????120111011000100?000??12031010123102300110?011101211

Edgarosaurus\_muddi

100101?021001020111010001??0?0??001000010?200102220011101000110?01?02?2?1?0????1002211?01??????10122?1300100201100011011110?120011?110111100?010100000121001?1132011201000000000???01????????????????????????????????????????????????????00?00??????0010?2?0?3?10??0101??01211

Plesiopleurodon\_wellesi

00010??0?100102?1120?000???2?0?????????????1???222201010?10?11????????????????????????????????????????????????0001?11???110?1????1?000210?0?????????????100?011320?120100?0?0?0??0??110?????0??101????????????20110?1?01??????????????????????????????1012?1??????????????????

Richmond\_pliosaur

00010120110011201120?000???2?0??00??01010??1???2222010101100111101?????????????1?022??001???00???1?2?100????1??001??????1???11????100011020?11101000?0210001?02320?1201001000100100?1100?00101010011??1???????20?1??????????20100121011200110110111200101221022101100011101?10

Stenorhynchosaurus\_munozi

0002012?21??00210??01001??002????1??00?????00????????????????0????????????????????12?0?0?11?100???2110310?????1?000010??001?1110?0?10101021?0??????????10002???3211?00?????01?????2????????????????20?1???2000??200??2??????????????10???0?101??010???101????32101102001211?01

Anguanax\_zignoi

??0?01?0?????????????????????????1???????????????????????????0?????????????????????????????????????????????????????11???01?????????????10?0????0????11??0?01?????0??10?????????????????????00??????????????????????????????????????????????????0??0???00??1????1?1?0?0????1??1

Makhaira\_rossica

0??????????????????????????????????????????????????????????????????????????????????????????????????????????????100??????????11????20??010?10????????????????????????????????????????11???????????????????????????????????????????1????????????????????????????????????????????

Luskhan\_itilensis

0102012??21100210??0?00001?000???1?0000100200?0023120100010??010??10?11?10?1?11??01??????????????12110????????10000110?0001?113??03000?1??2001101??01?010001112321120000002011201???010????0010001?00?1??021002020000201????0023?1??1??000?001010102001012?0033000?02010211?11

Palmulasaurus\_quadratus

00?2????????00????????00???????????????????????????????????????????????????????????????????????????????????????000??????????1?????1000211?01????????????????????????????????????1???11????????01???????????????????????????0101200210022100?01??120200101?20022101100011101211

Pahasapasaurus\_haasi

00020?2?2???00??1110??00???0????00?0?10????1??????????1?????????00?0???????1???1?02?1000?????0?0?12???200??????00???????????1?????2000211101111?100???2?1001???320???0?????0???????????????????????????????????????????????????????????2100101??110201100????1210??00011101?10

Polycotylus\_latipinnis

00120?20?1??102?1110100011?000???0??01010021???223210111010?111101???????????????01?11111000000111?2?120?1?10?1001?11011111?122011100011020011101002102200011113201120100100010010201110??01110000100?1000001020121012?11?1110100111113210??011?111200102221033101101011001211

Thililua\_longicollis

000210?0?10000201110??0011?000??001?010????1?????220??11??0?11?????????????????????????????????????????????????0000?????1???1?????100?111?0??0?????????31101??2320????????1?0??1???0??????????????????????????????????????????????????????????????????????????????????????????

Trinacromerum\_bentonianum

00020121?1?000211110100011?000???0??01010021???1?31?11110???01??0????12010???????01311111??????11122?13001?00??001?11???10??12???1?000211200?1101000?02?00012??3201?201000?00?00????11??????1?000???11101120?0201010020110111?110?111?32????0?????1???10?2???33?0??01011001211

Dolichorhynchops\_osborni

0012012011000020111010000110001?001001010021???22311?1110100110?01102?201001?01100131111100100011122?01001010?1000011011101?120011100021120?011010001021000101232011?010000001001120110?0000???11??101101000002011100201101110110121113210100000101200102211033101101011001?11

Dolichorhynchops\_bonneri

00120120100000210??010000110001?001001010021???223010111010?110??1?0?1?????1?????01311??10??00?11122?0200100??10000010111?101220101000111200?110120010110001111320?120100?000?10?1101100??001??100?101101?002020111?02??101110110?110?12100101??111300102231033101101011001?11

Pliosaurus\_almanzaensis

?????????2????????????????????????????????????????????????????0?20????????????????121????1?00010?121?03?0?????1?11?01???000?12?0??????????1?????????????000????1?0???????????????????????????????????????????????????????????????????????????????????0???2????3???1?1??1??????

Pliosaurus\_patagonicus

???????????????????????????????????????????????????????????????????????????????????????????0?01???????????????111?0?????0???10?0????????0?1???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Rhaeticosaurus\_mertensi

????????????????????????????????????????????????????????????????????????????????????????????????????????????????11???????11?00???0?????0??0?2??????????31001[12]??1?0?2?0100001000??11?1000000[12]0??00???????????????????????????01000111000????100??1200010?1?0??1200?0?0?100????0

;

ccode [-.;

proc/;

**2. Second run of ‘unordered’ parsimony analysis (2ndUOPA)**

xread

'Exported from NEXUS Data Editor'

270 99

Yunguisaurus\_liae

0001000??10000000??0010010?000010010?000?000110??200??00?????01020???????????????02?10???????0?0?0010020???10011001100?1001?1????13??0??????1??????????41000??00?000000?001??0??01210?0?00???0??????0?000?200????????????0?00122011?0000002000??11000?000?0?000000010000100000

Pistosaurus\_postcranium

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????20011100000000000110100101100010????101110?00?001?202100??0??001????0122210???1??????01?1?00000000???0???0?10????????0

Pistosaurus\_skull

010100?0010000000??001001000000?10000001000001001200?000????0010?0???????????????02??00000??0000?0010020????20?????????????????????0100??00???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Augustasaurus\_hagdorni

010100?0010?00000??00100100000000000000100?0010012101000010??????0???0?0000??????02??000?0110000?0010000????0?1100?10??1001??1???01010002100???00??21??41?01??000000200?0?10000011??0000???????????00?000?102?020000?0?????????????????000??00???100000000???0?100?1000???0?00

Bobosaurus\_forojuliensis

????????????????0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????02?0?00?00??01?2100000??110?12?000?00??001221100?10?1????????????????????????????????0122010?001??????0???1?000????????0???0?0??0??????

Macroplata\_tenuiceps

1101001??10?10101110??001??1001010?0???????0010????0?????????010100?012?100??01?100211???????????100??00??????1111??0??21???11??00201001110000100??210220001???110?120100??30?001?11100000?0110000?20110?1????0000000?001?0001?2012?002?????0?101?0?0?0?0?110?1???010??01?????

Anningasaura\_lymense

111000?0120?00??10000100?0010000100000?10000010112001000?10?0?1020?0110111010010?00211?1000000011?00?000?111??1110?100?1010?110??00010011000?0?00??0?0??10010??3?0?120100?031?1???????????????????????????????????????????????????????????????????????????????????????????????

Stratesaurus\_taylori

001000?0100100100??0110010000010?0?000010000010001001000010101101012002000010?00102211???01000010110?000000?2?111?11000110001?0?001000011000?0?00??2001?10010011100120100003101??1????00?0????????????1?????????????????????01022111??????????????????????????1???010??010??10

Avalonnectes\_arturi

??????????01??10????????10?????01??00001000001001100100001010???????????????????1??????0???????????????????????????????????????????????????????????????2100?00211001??100?0110001101101200?0110?00????1?01201???????????????0102?110??1?????????11020?000?110110?101000010?100

Eurycleidus\_arcuatus

???????????????????????????????????????????????????????????????????????????????????????????????????????????????111??????????1?????????01110?????????????100100211000201000010100?1?1101????0110100?201101120010201000100?10001020110001??????0101?02110010110????1?10????????0

Meyerasaurus\_victor

10?00?0?21??00??11??0100??0000???0??????????????????10?0??0101???0????????0??????022?0?1?01010111122?11000101?0111100?02110211???01?1001010?0???0???1?120?01?????00?20????0???0011211012002?110?0?0111?0?1????0201000?0001000102011?0011002100??12020?00021??11011010001101100

Maresaurus\_coccai

110100?1220?1???1120?1001?0?00?????????????00001120?10???10?0110?0?????0?????????0??11?000101010?122?1000???200111?00??2100?11???01?1?011100????0???????0001???2?0????1???030?????????????????????????????????????????????????????????????????????????????????????????????????

Borealonectes\_russelli

11010?1?210?102011100?00?0?0000??010?0010010000????1?000??0?0???20???12000???????022?1?0???????0??2???201?????111??00???1?0?110??0??1?01?10?00100??21?120001???2?0??20?????30?0????????1???????????????????????????????????????????????100??00?????1101012???2?011?0001???11?1

Atychodracon\_megacephalus

100101212201121010002100100100?000?000010000010012001000110101???0?201?000???0??1002111000100011011???00?0002001111?0??20?0?11??0??00001020?0???0???10120001???1100?201????10?00111?1012001??20?0?0??????????1??????????????01022110????????00??1?0201001?110?1??1010??0?????0

Archaeonectrus\_rostratus

1002002???0?102?1111??00?????????0?000?10000010012011000?1??01?????????????????????????????????????????????????11??1????1?????????????11120?0??????????2100100111000201???0?11?0110110110010??????0?????0?20?1??????????????01?2?1100?10001000??1?020?00??11011011010001101100

Rhomaleosaurus\_cramptoni

10000021220?1020100121101?00001?1000000???0001001201100011110?10?0???1?000???????02?1110?01010110122?1000000200?11?00??2100?11???01?1?01020?00?????????200???1211000??1?0?01?1?0002110?100?0????0?????1??????????????1??????0102?11000?10???00??1?021?001?1??110110100?11?1?00

Rhomaleosaurus\_zetlandicus

11000??1220?102010012110??00001??000???????001001?0110?0?1110110?????1?0?0????????2211??0?1????1?1?2??0??0??2001111000021002110000??1001020?0??????????200010??110?020100?010?00??2110?1???01201000????????????????????????????????????1?0??001212021000121101101101001?????0?

Rhomaleosaurus\_thorntoni

11??0???2?0?10??1021?1101?00?????0??0001000?????????????1?????????????????????????????1??01??01?????????????200111??10?11???11000?11100101000???????????0001???110?000100??10??01?21101?00?0110100??01100120210?0?000100?10001220110001??????0111?02100002110?????????????????

Thalassiodracon\_hawkinsii

00100001110100111120??0?1000???0000000?10020000001011000010110101010002000011000101011?00011001??100?000????0?11101100010000?1200?001001110010000??2101310010011100120100002100011101000001011000002011011001?00000001000?0001020111001000200000110100000010?11001010000101100

Hauffiosaurus\_longirostris

00?20??0?1??12111120??00???2????????????????????02???????????01001??0???1?0?????1110?????????????110?0??0?????1001?100?1100?11?0023010011200??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Hauffiosaurus\_tomistomimus

00020?10210?1?110??0100?0?0210100100???????00?00010100?0?101?01011??????1001????111011?0?0100010?100?010??????1000?100?1100?112002301001120?1100?????1231001?11110?100100002000011101010001??10???0???1??1?0?0????????????00????????00???0?1000012010000121?01101?1?0?11201?00

Hauffiosaurus\_zanoni

00?2??1??1??????????????0?0??????????0?10???????????00?001???010????????????????11101101?0100010?100?010????20100??100?1100??12002301?01120000?00??????310011?11100100100?020?00?????????0?01100000201101120??0020000?010?0001020?2?0001001000??11010?00121??11011010001101100

Marmornectes\_candrewi

0???????????00??0?????00???????????????????????0????10???0???0????????????????????????????????????????????????10100110?0000?111000201021020000000??21?1?0001???1200100100?200?1001??1?00?1?0010000??????1?0??000?00???00????00220111??2000??00110001000012100?1??1110??011???1

Peloneustes\_philarchus

10020120211100210??010001000101?010000010020010003121100010?00101100011000011?10102211100110?010?12110200???2110110110000001111000211001020001000??21?110001?121200110100000011001201100?1?0010001?00?1011000010000002000??1002301111022000?01??000210001220022101110111111111

Simolestes\_vorax

110101???21?10210??010001??010??0100000100200?0003111?000?0?0010110??11000????1???221110???????0?121?0210???210111??10?0000?111000??1?01010?0??00???111100011121?0?1000001200110????11?????0????0??20?10012010?02?000?0????000230??1102201??010100021010122001110111001111????

Pliosaurus\_funkei

???????0?????0????????????????????????????????????????????????2?2??????????????????????????????????????????????????01????00?1????0????010?11????????????0001???1????00???0?00?2?00??1100??????????????????????2000000200?????????????????0??0?0????2?01012???3?101?0101???1??1

Pliosaurus\_westburyensis

110101?0221110210??010011000011?1100000100200100231111000201002020???1????0????0?0121110011??????12110210???1?101?0010?200???13000?01011011?????????????0001???1?00?00?????00???00??1100??????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_carpenteri

11010????2??10210??0??011?00???????????????00?00231111???20?002020??????????????????11?00110?010??2110?1??????1011??10??0?0?1110002111010111???0????1?0?0001?0?1?0?1000000200120?0??110????????????1??1?0?2000?????0?2?0???????????????2????00????1???10?????3310?1?1011?11??1

Pliosaurus\_brachydeirus

11?1?????2??102?0??01001???0???????????????00?0???1??????????02020?????????????0?????????1?????0?12110310?????101??010?2000??13000?011010?1?0???????????0001???120??10???0?00?2010??1100????????????????????????????????????????????????0???00????0?????1?1??23???1?1??10????1

Pliosaurus\_macromerus

1101????22??10210??0??011?0????????????????00?0???1??????????0???0?????????????00022111001100010?12110310?????1011??10??000?11300010110101?1??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_brachyspondylus

???1?????????????????????????????????????????????????????????0????????????????????????????????????????????????1011?010??000?113000????01011?010?????1?010001???120??00?????01?20??20???????????????1??1??0???0???????200?????????????????????0110?02101012100????????????????1

Pliosaurus\_cf\_kevani

?????????????0???????????????????????????????????????????????????????????????????????????????????????????????????????????0????????????010?2?????????????0001???1?0??00???0?00?2?00??11??????????????0?1????????020000200???0002300111032????00??001?10101210023101101?11011211

Pliosaurus\_kevani

110101?022??10210??010011000011?1100?0010020010023021100020?00202000011010?0??10?022111001100010??????????????10??0010021001113?002111010?21??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Gallardosaurus\_iturraldei

??0?01?022?1??21????????10??????11?0000100200100?3121100020?011021???1????????????121110???0?010?12110310???211?????1???0?????????????????2????00??2111?00011??1?0?110?0??20??????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_rossicus

11?1?1??????10210??01001??????1?11000001??200?0??3111??????????????????????????????????????????????????????????1????????0?????????1?1?01011???????????????????????????????????????????????????????????1000200?2????0?2????????????????????????????????????????????????????????

Pliosaurus\_irgisensis

???????0??????21????????????????11?0000100200?0?231?11?002??0???2????1??????????????????????????????????????????????????????????????????????????????????000??1?1?0?1??000?200???????????????????????????????????????????????????????????001?0?????0???10??1???3???1????1?111??

Pliosaurus\_andrewsi

01020?2021??10210??0??00??00???????????????00?00?3?211?0??0?00??11??????????????102?11?00110?010?1211020????21111?0110000101111000211001010001001102??210001012110010000002001100120110??1?0010000??????????????????????????00230110???200??01??02021010122003210?100011011211

Liopleurodon\_ferox

11010120221110210??010001000101?11?0000100200000031211000?0100101100?1100001??101022111001101110?12110210???2111110010?0010?111000111101010001100??0110100011121200100101000011000?0110????2010100????1??0?000?????0??01???1????????10320???010???02101012?0?2?101?0001???1?11

Kronosaurus\_queenslandicus

??0?0?20?1??????0?????????????????????????????????????????01000???00011000?01110?111?0???????????12110?10??????????0????001????0??????01010?011?0??2??00000?11?3211?0?000?0001??0?20?1??0??2?10000?00?10?0?????02??0020????1????????103??????????????????????????????????1????

DORK\_G\_1\_2

?????????????0?????????????????????????????00100231210???20?0?????????????????????????????????????????????????????????????????????????110?0???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Megacephalosaurus\_eulerti

010200?0211100210??110000010210?111000010120010023121000120?00???????????????????011???00011000101211031010?2111000010?0001?1110000000110000???????????????????1??????????????????????????????????????????????????????????????????????????????????????????????????????????????

Brachauchenius\_lucasi

00020120211100210??010001000210?111?0001012001000312100012??00???????????????????011?0100?1011?0??2100310???211???001?00001?11?????????10?0?0???0?????000002????211?00?????????00??001???????????????????????????????????????????????????????????????????????????????????11111

Brachauchenius\_MNA\_V9433

0102?????1?100210??0100010?0????????0001???00?002?1210?0?20?0????0?????????????????????00????110??2110210???2111000010?0001?1110000000110000???????????0000211?3211100000?200?2?0???01??????????????0?1???????22200002?????11??0011?10????????????????????????????????????????

QM\_f51291

????01??2?????210??010?????0210?1110000????0010???12?????????????????????????????????0?00????????????????????????????????????????????????10???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Attenborosaurus\_conybeari

00010010???110??112???0010?0?????0??0001002??????2??10000???11??????????????????1?2???????????????????????????0110??0???0?????????10100???0?2??????????310??011110????1???0?00??11101100?0???1???1?20?10?1????0220000?000?310?02??1?0010001000??1??10?00?????1?001?100???01101

Plesiosaurus\_dolichodeirus

001100?0110?00100??0010010?000010010000100?001000100100001010110?010?02000?1111?10?01100?01000110100?000?1110?0100?100?1000???????100001110?2???0????01410010121?00100101003?00011111100001000010??211101100110000000?000?000002012100100020000?1102010000200110?1010000?01100

Eoplesiosaurus\_antiquior

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2??????????4100?0111?0?12?1???03??0??????????01000?11?02??1001002?0?0??00???????0??2?11?00110020000?11010100??1?0110?1010000101100

Eretmosaurus\_rugosus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100110?100?12010000?000111??11?0???0000?01????1?????????0??0???????0010201200011000000??11021?100020011011010000201100

Westphaliasaurus\_simonsensii

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2????????????0011021?0??0010?1031000111?1?0010?0000101?211100120??00000001??10000??20?20001?????00011002100011100110110100011?1??1

Seelyosaurus\_guilelmiimperatoris

00000?00?10?02?????0???????0?????0??0011001????1?1?01000?0??11?????????????????????????????????????????????????10??100?1010???????100001100?2??????????3100?1221000???1???00?00?1200110010?100001101101001201?10030?1?0???300?02??200011000100??11020?100?20011011000011201101

Microcleidus\_tournemirensis

0000000?120102100??0010010000000001011110010010002001000110?1????1?????000?????0112?110000??00?0?12100100???20????????????????????11000110012?????????142101112100?20?100?0010011200111010?????????201100120211013010?010?300122012000110????0??1?020?100?2?0110110100012?1??1

Microcleidus\_brachypterygius

0011000?110102100??0010010000000101011110010010102001000100?????1???????????????101??100?0010000?12100000???20?????????????????????0000110012?????????2321011121?00??1????00100?12011110?03100011?0210???1????20130?0?01???101220?10??01002000??11021?100?2??11010010011101101

Microcleidus\_homalospondylus

0000000011010210???0010020?000?010?0111100100101020010001??11110110010200001??001021?1?00????000??2100100???2001001??00?0???102???10000??0012??????????42101112100020110010010011201111010?1000011??1011110001?01?010101???00122012000010?20000011021?100110011011010011201101

Plesiopterys\_wildi

00100?0?1???00????????00???00??1?0?0???10??01?0001001000?00?0?10101110200001001010110???1????0011?00??00?100???20??100?1000?0?2??0?00?01110??????????02420011121101?001??0001001111?1100003000000?01?11?01201??0??0???010?3?0102012?001???00?000110200101?2??11001010011101110

Cryptoclidus\_eurymerus

00100?0010?101100??00100101000010000020100201001011010000000010?1011101101?111011111??00101100011?00?0????000?02001100?1000?0021?0200001110121111101?013100111232011001110000000111011000000010001121011001010201201020200?1100210110112010?101113032010122101300110?2??001211

Tricleidus\_seeleyi

01100???????011010?00?0010?000?100?????????01001?3001000?000010?00?0111111?????111110?????????011200?000?1100?0201110001000?0021?01110011001?11?1101?02210011123201100111000100?11?01100???????????110110000002012010202?13????????????210??1011130210101221023001101111101211

Muraenosaurus\_leedsii

00????????0?01100??001001??000?10??????????010?0?????1???0???10?00?0????11?????11011??????????????0???????????0201010002000?0021?010100110012?1?1101??14210112232012001110001001??11111000?200?111???????0???0?????1?2020?3?1012?021??12????1001230311101221023001100111001210

Kimmerosaurus\_langhami

??1??0?1??0?0????????????0?????10??0??????20100000102000000011101010201101?101111111?????????????200?0????????0200110001000?002??0?00?01220???1?1001?01?00011??3?01100111???1?0???????????????????????????????????????????????????????????????????????????????????????????????

Pantosaurus\_striatus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100111?320??00???000100??1??110000?2000111?????????????????????????01001?021011200??10????0210101??1?1?10???211???1211

Picrocleidus\_beloclis

?????????????????????????????????????????????????????0????0?010??0?????????????10012??????????????????????????????1100?1000???2??2?????11?????1?1101?02411011223201200111000100111?011?0?0?200?101001011002010201201020201?01?12?021112200??101???02111012210110010011111?1?10

Tatenectes\_laramiensis

???????0?????????????????0??????0??????1????????????2000?0000??????????????????????????????????11????????0?1???????????????????????????11??????01001????00011??32011001?1000100?110?110000??????????1011???????01??1020101?10?110021011210??10????0210101??1?2?001?0211??01??1

Plesiosaurus\_mansellii

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1111101??2?1101???320??00?????01?01??1111?????1010011??0???????????2??1?202????????????????????????????????????????????2?????????

Colymbosaurus\_trochanterius

???????????????????????????????????????????????????????????????????????????????????????????????????????????????????100?1000??????0????????????1?1110??2410012??320?200111??01?01??1011??00?2010101??0???????????2??102?2???????????????201??10111?2210101221022101102?11101211

Djupedallia\_engeri

??????0?????0?????????????????????????????????????????????00???????0?01111????????????????????????????????????020??????????????????00?0??1??2011???100?510012113201200111030100110??1100??????????????11?0???0?0??01??????3????????????2?0??????1?02?0?012?1???101102???1?1211

Spitrasaurus\_spp

??????0?????0?????????????????????????????????????????0???00??1010?????????????1??????????????????0???????????0201?100?1000???2??0?00?01110?20111111??2521012213201200111030100110?01100??????????????11?0???0?0??01???2???????????????2?11?????1?02?0?012?1???101102?1???1?11

Abyssosaurus\_nataliae

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???1110??1?1001???3201200111??01?01??1011??0???0???????0010000100??2??10?0?001?1?1101110??2?1??1????10???10?22?0?3??110???1001211

Umoonasaurus\_demoscyllus

00000100112??1101020??00??00????0??????????0?002222?10???10?11????1??12?11?0??0??022?????0?????11122?1211000????????0??1111???????1111010?01????????????1001????20?1??1010??00?110101102000201?00?1???1?01?010?????????????0???????????21????0111?02001022210?2???1?0??10?1??1

Nichollssaura\_borealis

0000010011200010102010001100000100?000010010000122301010010011??211?2??0???00000?0221110101100011122?13110000?0111110??0101?112??02?1001010100100??20022100100132011?010??000??1102?101?00000?????????10110020??????????????2?12102?01?2??0000??1??200101?21012101100011101110

Leptocleidus\_capensis

010001?1112?1010102002001?0000?10??0000??01001022?201010?0??01??21?????0?????????0221110?01?00011122?12110001?????1110?0111???2?111111010101???????????210010??320?1?0100?0?0?0?????1??????????????????????????????????????????????????2????00????0???????????2???1?0??10?1???

Leptocleidus\_superstes

??0?0??1?1?0????10??????1??????????????????0?10222201010?100011121?0011?01???????02211???????????122??31????1???????????????????????????????????????????0?01?0132011001000??00?110?11102???1011001?10110011020??1?100200102??????????????????01???02001012?0??????????????????

Vectocleidus\_pastorum

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?01??0?1??1010??00??10??1102?????????????1???1?02???1??01?10?0????????????????????????????????????????????????????

Brancasaurus\_brancai

0010?000100000??101002001?00000?0?1000???0101?02223010?0?00?011101101120101000100022?????011000???0???????????01???100?1110???2??121100111?120100??20014100100232012?0101100000110101102000101?1011???1?01?0201?10?0?210?0201012102101121????0111002001022200321?11???110?1???

Gronausaurus\_wegneri

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?12?20?2001111?000?1110011100002011101????1????????????0?210???01012102101021????0112?02000022210?1???1?0????????1

Speeton\_clay\_plesiosaurian

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???????????2101012320120011110010011201111000?20?1111??1011?1??20??1??002?????010121011011200??00102103001022?1021001100011101?11

Wapuskanectes\_betsynichollsae

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1??1??0???????????2101?2?110?1110110?10??3????????????200???01???03000022???????????????????0

Futabasaurus\_suzukii

00??000?1?0?00??0??00?0?2?0000????????????????????0???1??????????????????????????????????0110000???????????????100??????0?????????100001100???????????????11?22?2022001111?010?11110111000??????????????????????????????01301?1??01?0?1100200000220300102221122101100011101?10

Callawayasaurus\_colombiensis

000010?0?10000??10100?0020?000?10????????01010000220101010001111011??02?1010??1?002211001????0?0???2?1100???1?1101??0??20?????2??010000110012??????????5210102232022001111?0100111211110???????????200100?11001120010?10?01?????????00??0???100?220300102?3101200?10?0111??2?1

Eromangasaurus\_australis

000000???10000??10200?0020?000??00?000010??0010???????101?0?11????????????????????2????????????0???????????????1011?????010????????000011001?01?1101??2?2101???3?0??????????1?0???????????????????????????????????????????????????????????????????????????????????????????????

Kaiwhekea\_katiki

00001010??000???1020020020?000?????????11????0?0?32?2111000?00????????????????????????????????????????????????0101?10??1000??????0300001120?2??????????51011122320?2?0111?10100?11111?10???2????0??????????????????????????????????????000??00??11?32?11??3?12110100?0012?1??0

Aristonectes\_parvidens

00?010??1?0000201??00200200000??00?????11??01010?3212?1?0000?00?1?01212010???????????????0?10000??????????????0101010??1000???????3000011200?1101101?02?1111???3???200111??01?0???????????????????????????????????????????????????????????????????????????????????????????????

Libonectes\_morgani

010010?011000020102002002000000?00110001001110??0?21??111?00010?010?20201010?00100221100101?00?0?122?1200???2101000101?2000?112000101001?0012???1?????1621?122?320?200111??01??1???????????????????21011??????11100?0?100?1?????????????00??00????????10??????200??01?1???????

Hydrotherosaurus\_alexandrae

000010?0??0000201?100?002??0000?0011000100111?????2121?111??01?????????????????????????????????????????????????100010?1?01??112???10000110012???1?????1521112223202200111?101001110011100002011?11?1001?00001011200?020????120111011000100?000??12031010123102300110?011101211

Edgarosaurus\_muddi

100101?021001020111010001??0?0??001000010?200102220011101000110?01?02?2?1?0????1002211?01??????10122?1300100201100011011110?120011?110111100?010100000121001?1132011201000000000???01????????????????????????????????????????????????????00?00??????0010?2?0?3?10??0101??01211

Plesiopleurodon\_wellesi

00010??0?100102?1120?000???2?0?????????????1???222201010?10?11????????????????????????????????????????????????0001?11???110?1????1?000210?0?????????????100?011320?120100?0?0?0??0??110?????0??101????????????20110?1?01??????????????????????????????1012?1??????????????????

Richmond\_pliosaur

00010120110011201120?000???2?0??00??01010??1???2222010101100111101?????????????1?022??001???00???1?2?100????1??001??????1???11????100011020?11101000?0210001?02320?1201001000100100?1100?00101010011??1???????20?1??????????20100121011200110110111200101221022101100011101?10

Stenorhynchosaurus\_munozi

0002012?21??00210??01001??002????1??00?????00????????????????0????????????????????12?0?0?11?100???2110310?????1?000010??001?1110?0?10101021?0??????????10002???3211?00?????01?????2????????????????20?1???2000??200??2??????????????10???0?101??010???101????32101102001211?01

Anguanax\_zignoi

??0?01?0?????????????????????????1???????????????????????????0?????????????????????????????????????????????????????11???01?????????????10?0????0????11??0?01?????0??10?????????????????????00??????????????????????????????????????????????????0??0???00??1????1?1?0?0????1??1

Makhaira\_rossica

0??????????????????????????????????????????????????????????????????????????????????????????????????????????????100??????????11????20??010?10????????????????????????????????????????11???????????????????????????????????????????1????????????????????????????????????????????

Luskhan\_itilensis

0102012??21100210??0?00001?000???1?0000100200?0023120100010??010??10?11?10?1?11??01??????????????12110????????10000110?0001?113??03000?1??2001101??01?010001112321120000002011201???010????0010001?00?1??021002020000201????0023?1??1??000?001010102001012?0033000?02010211?11

Palmulasaurus\_quadratus

00?2????????00????????00???????????????????????????????????????????????????????????????????????????????????????000??????????1?????1000211?01????????????????????????????????????1???11????????01???????????????????????????0101200210022100?01??120200101?20022101100011101211

Pahasapasaurus\_haasi

00020?2?2???00??1110??00???0????00?0?10????1??????????1?????????00?0???????1???1?02?1000?????0?0?12???200??????00???????????1?????2000211101111?100???2?1001???320???0?????0???????????????????????????????????????????????????????????2100101??110201100????1210??00011101?10

Polycotylus\_latipinnis

00120?20?1??102?1110100011?000???0??01010021???223210111010?111101???????????????01?11111000000111?2?120?1?10?1001?11011111?122011100011020011101002102200011113201120100100010010201110??01110000100?1000001020121012?11?1110100111113210??011?111200102221033101101011001211

Thililua\_longicollis

000210?0?10000201110??0011?000??001?010????1?????220??11??0?11?????????????????????????????????????????????????0000?????1???1?????100?111?0??0?????????31101??2320????????1?0??1???0??????????????????????????????????????????????????????????????????????????????????????????

Trinacromerum\_bentonianum

00020121?1?000211110100011?000???0??01010021???1?31?11110???01??0????12010???????01311111??????11122?13001?00??001?11???10??12???1?000211200?1101000?02?00012??3201?201000?00?00????11??????1?000???11101120?0201010020110111?110?111?32????0?????1???10?2???33?0??01011001211

Dolichorhynchops\_osborni

0012012011000020111010000110001?001001010021???22311?1110100110?01102?201001?01100131111100100011122?01001010?1000011011101?120011100021120?011010001021000101232011?010000001001120110?0000???11??101101000002011100201101110110121113210100000101200102211033101101011001?11

Dolichorhynchops\_bonneri

00120120100000210??010000110001?001001010021???223010111010?110??1?0?1?????1?????01311??10??00?11122?0200100??10000010111?101220101000111200?110120010110001111320?120100?000?10?1101100??001??100?101101?002020111?02??101110110?110?12100101??111300102231033101101011001?11

Pliosaurus\_almanzaensis

?????????2????????????????????????????????????????????????????0?20????????????????121????1?00010?121?03?0?????1?11?01???000?12?0??????????1?????????????000????1?0???????????????????????????????????????????????????????????????????????????????????0???2????3???1?1??1??????

Pliosaurus\_patagonicus

???????????????????????????????????????????????????????????????????????????????????????????0?01???????????????111?0?????0???10?0????????0?1???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Rhaeticosaurus\_mertensi

????????????????????????????????????????????????????????????????????????????????????????????????????????????????11???????11?00???0?????0??0?2??????????31001[12]??1?0?2?0100001000??11?1000000[12]0??00???????????????????????????01000111000????100??1200010?1?0??1200?0?0?100????0

;

ccode [-.;

proc/;

**3. First run of ‘ordered’ parsimony analysis (1stOPA)**

xread

'Exported from NEXUS Data Editor'

270 99

Yunguisaurus\_liae

0001000??10000000??0010010?000010010?000?000110??200??00?????01020???????????????02?10???????0?0?0010020???10011001100?1001?1????13??0??????1??????????41000??00?000000?001??0??01210?0?00???0??????0?000?200????????????0?00122011?0000002000??11000?000?0?000000010000100000

Pistosaurus\_postcranium

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????20011100000000000110100101100010????101110?00?001?202100??0??001????0122210???1??????01?1?00000000???0???0?10????????0

Pistosaurus\_skull

010100?0010000000??001001000000?10000001000001001200?000????0010?0???????????????02??00000??0000?0010020????20?????????????????????0100??00???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Augustasaurus\_hagdorni

010100?0010?00000??00100100000000000000100?0010012101000010??????0???0?0000??????02??000?0110000?0010000????0?1100?10??1001??1???01010002100???00??21??41?01??000000200?0?10000011??0000???????????00?000?102?020000?0?????????????????000??00???100000000???0?100?1000???0?00

Bobosaurus\_forojuliensis

????????????????0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????02?0?00?00??01?2100000??110?12?000?00??001221100?10?1????????????????????????????????0122010?001??????0???1?000????????0???0?0??0??????

Macroplata\_tenuiceps

1101001??10?10101110??001??1001010?0???????0010????0?????????010100?012?100??01?100211???????????100??00??????1111??0??21???11??00201001110000100??210220001???110?120100??30?001?11100000?0110000?20110?1????0000000?001?0001?2012?002?????0?101?0?0?0?0?110?1???010??01?????

Anningasaura\_lymense

111000?0120?00??10000100?0010000100000?10000010112001000?10?0?1020?0110111010010?00211?1000000011?00?000?111??1110?100?1010?110??00010011000?0?00??0?0??10010??3?0?120100?031?1???????????????????????????????????????????????????????????????????????????????????????????????

Stratesaurus\_taylori

001000?0100100100??0110010000010?0?000010000010001001000010101101012002000010?00102211???01000010110?000000?2?111?11000110001?0?001000011000?0?00??2001?10010011100120100003101??1????00?0????????????1?????????????????????01022111??????????????????????????1???010??010??10

Avalonnectes\_arturi

??????????01??10????????10?????01??00001000001001100100001010???????????????????1??????0???????????????????????????????????????????????????????????????2100?00211001??100?0110001101101200?0110?00????1?01201???????????????0102?110??1?????????11020?000?110110?101000010?100

Eurycleidus\_arcuatus

???????????????????????????????????????????????????????????????????????????????????????????????????????????????111??????????1?????????01110?????????????100100211000201000010100?1?1101????0110100?201101120010201000100?10001020110001??????0101?02110010110????1?10????????0

Meyerasaurus\_victor

10?00?0?21??00??11??0100??0000???0??????????????????10?0??0101???0????????0??????022?0?1?01010111122?11000101?0111100?02110211???01?1001010?0???0???1?120?01?????00?20????0???0011211012002?110?0?0111?0?1????0201000?0001000102011?0011002100??12020?00021??11011010001101100

Maresaurus\_coccai

110100?1220?1???1120?1001?0?00?????????????00001120?10???10?0110?0?????0?????????0??11?000101010?122?1000???200111?00??2100?11???01?1?011100????0???????0001???2?0????1???030?????????????????????????????????????????????????????????????????????????????????????????????????

Borealonectes\_russelli

11010?1?210?102011100?00?0?0000??010?0010010000????1?000??0?0???20???12000???????022?1?0???????0??2???201?????111??00???1?0?110??0??1?01?10?00100??21?120001???2?0??20?????30?0????????1???????????????????????????????????????????????100??00?????1101012???2?011?0001???11?1

Atychodracon\_megacephalus

100101212201121010002100100100?000?000010000010012001000110101???0?201?000???0??1002111000100011011???00?0002001111?0??20?0?11??0??00001020?0???0???10120001???1100?201????10?00111?1012001??20?0?0??????????1??????????????01022110????????00??1?0201001?110?1??1010??0?????0

Archaeonectrus\_rostratus

1002002???0?102?1111??00?????????0?000?10000010012011000?1??01?????????????????????????????????????????????????11??1????1?????????????11120?0??????????2100100111000201???0?11?0110110110010??????0?????0?20?1??????????????01?2?1100?10001000??1?020?00??11011011010001101100

Rhomaleosaurus\_cramptoni

10000021220?1020100121101?00001?1000000???0001001201100011110?10?0???1?000???????02?1110?01010110122?1000000200?11?00??2100?11???01?1?01020?00?????????200???1211000??1?0?01?1?0002110?100?0????0?????1??????????????1??????0102?11000?10???00??1?021?001?1??110110100?11?1?00

Rhomaleosaurus\_zetlandicus

11000??1220?102010012110??00001??000???????001001?0110?0?1110110?????1?0?0????????2211??0?1????1?1?2??0??0??2001111000021002110000??1001020?0??????????200010??110?020100?010?00??2110?1???01201000????????????????????????????????????1?0??001212021000121101101101001?????0?

Rhomaleosaurus\_thorntoni

11??0???2?0?10??1021?1101?00?????0??0001000?????????????1?????????????????????????????1??01??01?????????????200111??10?11???11000?11100101000???????????0001???110?000100??10??01?21101?00?0110100??01100120210?0?000100?10001220110001??????0111?02100002110?????????????????

Thalassiodracon\_hawkinsii

00100001110100111120??0?1000???0000000?10020000001011000010110101010002000011000101011?00011001??100?000????0?11101100010000?1200?001001110010000??2101310010011100120100002100011101000001011000002011011001?00000001000?0001020111001000200000110100000010?11001010000101100

Hauffiosaurus\_longirostris

00?20??0?1??12111120??00???2????????????????????02???????????01001??0???1?0?????1110?????????????110?0??0?????1001?100?1100?11?0023010011200??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Hauffiosaurus\_tomistomimus

00020?10210?1?110??0100?0?0210100100???????00?00010100?0?101?01011??????1001????111011?0?0100010?100?010??????1000?100?1100?112002301001120?1100?????1231001?11110?100100002000011101010001??10???0???1??1?0?0????????????00????????00???0?1000012010000121?01101?1?0?11201?00

Hauffiosaurus\_zanoni

00?2??1??1??????????????0?0??????????0?10???????????00?001???010????????????????11101101?0100010?100?010????20100??100?1100??12002301?01120000?00??????310011?11100100100?020?00?????????0?01100000201101120??0020000?010?0001020?2?0001001000??11010?00121??11011010001101100

Marmornectes\_candrewi

0???????????00??0?????00???????????????????????0????10???0???0????????????????????????????????????????????????10100110?0000?111000201021020000000??21?1?0001???1200100100?200?1001??1?00?1?0010000??????1?0??000?00???00????00220111??2000??00110001000012100?1??1110??011???1

Peloneustes\_philarchus

10020120211100210??010001000101?010000010020010003121100010?00101100011000011?10102211100110?010?12110200???2110110110000001111000211001020001000??21?110001?121200110100000011001201100?1?0010001?00?1011000010000002000??1002301111022000?01??000210001220022101110111111111

Simolestes\_vorax

110101???21?10210??010001??010??0100000100200?0003111?000?0?0010110??11000????1???221110???????0?121?0210???210111??10?0000?111000??1?01010?0??00???111100011121?0?1000001200110????11?????0????0??20?10012010?02?000?0????000230??1102201??010100021010122001110111001111????

Pliosaurus\_funkei

???????0?????0????????????????????????????????????????????????2?2??????????????????????????????????????????????????01????00?1????0????010?11????????????0001???1????00???0?00?2?00??1100??????????????????????2000000200?????????????????0??0?0????2?01012???3?101?0101???1??1

Pliosaurus\_westburyensis

110101?0221110210??010011000011?1100000100200100231111000201002020???1????0????0?0121110011??????12110210???1?101?0010?200???13000?01011011?????????????0001???1?00?00?????00???00??1100??????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_carpenteri

11010????2??10210??0??011?00???????????????00?00231111???20?002020??????????????????11?00110?010??2110?1??????1011??10??0?0?1110002111010111???0????1?0?0001?0?1?0?1000000200120?0??110????????????1??1?0?2000?????0?2?0???????????????2????00????1???10?????3310?1?1011?11??1

Pliosaurus\_brachydeirus

11?1?????2??102?0??01001???0???????????????00?0???1??????????02020?????????????0?????????1?????0?12110310?????101??010?2000??13000?011010?1?0???????????0001???120??10???0?00?2010??1100????????????????????????????????????????????????0???00????0?????1?1??23???1?1??10????1

Pliosaurus\_macromerus

1101????22??10210??0??011?0????????????????00?0???1??????????0???0?????????????00022111001100010?12110310?????1011??10??000?11300010110101?1??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_brachyspondylus

???1?????????????????????????????????????????????????????????0????????????????????????????????????????????????1011?010??000?113000????01011?010?????1?010001???120??00?????01?20??20???????????????1??1??0???0???????200?????????????????????0110?02101012100????????????????1

Pliosaurus\_cf\_kevani

?????????????0???????????????????????????????????????????????????????????????????????????????????????????????????????????0????????????010?2?????????????0001???1?0??00???0?00?2?00??11??????????????0?1????????020000200???0002300111032????00??001?10101210023101101?11011211

Pliosaurus\_kevani

110101?022??10210??010011000011?1100?0010020010023021100020?00202000011010?0??10?022111001100010??????????????10??0010021001113?002111010?21??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Gallardosaurus\_iturraldei

??0?01?022?1??21????????10??????11?0000100200100?3121100020?011021???1????????????121110???0?010?12110310???211?????1???0?????????????????2????00??2111?00011??1?0?110?0??20??????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_rossicus

11?1?1??????10210??01001??????1?11000001??200?0??3111??????????????????????????????????????????????????????????1????????0?????????1?1?01011???????????????????????????????????????????????????????????1000200?2????0?2????????????????????????????????????????????????????????

Pliosaurus\_irgisensis

???????0??????21????????????????11?0000100200?0?231?11?002??0???2????1??????????????????????????????????????????????????????????????????????????????????000??1?1?0?1??000?200???????????????????????????????????????????????????????????001?0?????0???10??1???3???1????1?111??

Pliosaurus\_andrewsi

01020?2021??10210??0??00??00???????????????00?00?3?211?0??0?00??11??????????????102?11?00110?010?1211020????21111?0110000101111000211001010001001102??210001012110010000002001100120110??1?0010000??????????????????????????00230110???200??01??02021010122003210?100011011211

Liopleurodon\_ferox

11010120221110210??010001000101?11?0000100200000031211000?0100101100?1100001??101022111001101110?12110210???2111110010?0010?111000111101010001100??0110100011121200100101000011000?0110????2010100????1??0?000?????0??01???1????????10320???010???02101012?0?2?101?0001???1?11

Kronosaurus\_queenslandicus

??0?0?20?1??????0?????????????????????????????????????????01000???00011000?01110?111?0???????????12110?10??????????0????001????0??????01010?011?0??2??00000?11?3211?0?000?0001??0?20?1??0??2?10000?00?10?0?????02??0020????1????????103??????????????????????????????????1????

DORK\_G\_1\_2

?????????????0?????????????????????????????00100231210???20?0?????????????????????????????????????????????????????????????????????????110?0???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Megacephalosaurus\_eulerti

010200?0211100210??110000010210?111000010120010023121000120?00???????????????????011???00011000101211031010?2111000010?0001?1110000000110100???????????????????1??????????????????????????????????????????????????????????????????????????????????????????????????????????????

Brachauchenius\_lucasi

00020120211100210??010001000210?111?0001012001000312100012??00???????????????????011?0100?1011?0??2100310???211???001?00001?11?????????10?0?0???0?????000002????211?00?????????00??001???????????????????????????????????????????????????????????????????????????????????11111

Brachauchenius\_MNA\_V9433

0102?????1?100210??0100010?0????????0001???00?002?1210?0?20?0????0?????????????????????00????110??2110210???2111000010?0001?1110000000110100???????????0000211?3211100000?200?2?0???01??????????????0?1???????22200002?????11??0011?10????????????????????????????????????????

QM\_f51291

????01??2?????210??010?????0210?1110000????0010???12?????????????????????????????????0?00????????????????????????????????????????????????10???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Attenborosaurus\_conybeari

00010010???110??112???0010?0?????0??0001002??????2??10000???11??????????????????1?2???????????????????????????0110??0???0?????????10100???0?2??????????310??011110????1???0?00??11101100?0???1???1?20?10?1????0220000?000?310?02??1?0010001000??1??10?00?????1?001?100???01101

Plesiosaurus\_dolichodeirus

001100?0110?00100??0010010?000010010000100?001000100100001010110?010?02000?1111?10?01100?01000110100?000?1110?0100?100?1000???????100001110?2???0????01410010121?00100101003?00011111100001000010??211101100110000000?000?000002012100100020000?1102010000200110?1010000?01100

Eoplesiosaurus\_antiquior

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2??????????4100?0111?0?12?1???03??0??????????01000?11?02??1001002?0?0??00???????0??2?11?00110020000?11010100??1?0110?1010000101100

Eretmosaurus\_rugosus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100110?100?12010000?000111??11?0???0000?01????1?????????0??0???????0010201200011000000??11021?100020011011010000201100

Westphaliasaurus\_simonsensii

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2????????????0011021?0??0010?1031000111?1?0010?0000101?211100120??00000001??10000??20?20001?????00011002100011100110110100011?1??1

Seelyosaurus\_guilelmiimperatoris

00000?00?10?02?????0???????0?????0??0011001????1?1?01000?0??11?????????????????????????????????????????????????10??100?1010???????100001100?2??????????3100?1221000???1???00?00?1200110010?100001101101001201?10030?1?0???300?02??200011000100??11020?100?20011011000011201101

Microcleidus\_tournemirensis

0000000?120102100??0010010000000001011110010010002001000110?1????1?????000?????0112?110000??00?0?12100100???20????????????????????11000110012?????????142101112100?20?100?0010011200111010?????????201100120211013010?010?300122012000110????0??1?020?100?2?0110110100012?1??1

Microcleidus\_brachypterygius

0011000?110102100??0010010000000101011110010010102001000100?????1???????????????101??100?0010000?12100000???20?????????????????????0000110012?????????2321011121?00??1????00100?12011110?03100011?0210???1????20130?0?01???101220?10??01002000??11021?100?2??11010010011101101

Microcleidus\_homalospondylus

0000000011010210???0010020?000?010?0111100100101020010001??11110110010200001??001021?1?00????000??2100100???2001001??00?0???102???10000??0012??????????42101112100020110010010011201111010?1000011??1011110001?01?010101???00122012000010?20000011021?100110011011010011201101

Plesiopterys\_wildi

00100?0?1???00????????00???00??1?0?0???10??01?0001001000?00?0?10101110200001001010110???1????0011?00??00?100???20??100?1000?0?2??0?00?01110??????????02420011121101?001??0001001111?1100003000000?01?11?01201??0??0???010?3?0102012?001???00?000110200101?2??11001010011101110

Cryptoclidus\_eurymerus

00100?0010?101100??00100101000010000020100201001011010000000010?1011101101?111011111??00101100011?00?0????000?02001100?1000?0021?0200001110121111101?013100111232011001110000000111011000000010001121011001010201201020200?1100210110112010?101113032010122101300110?2??001211

Tricleidus\_seeleyi

01100???????011010?00?0010?000?100?????????01001?3001000?000010?00?0111111?????111110?????????011200?000?1100?0201110001000?0021?01110011001?11?1101?02210011123201100111000100?11?01100???????????110110000002012010202?13????????????210??1011130210101221023001101111101211

Muraenosaurus\_leedsii

00????????0?01100??001001??000?10??????????010?0?????1???0???10?00?0????11?????11011??????????????0???????????0201010002000?0021?010100110012?1?1101??14210112232012001110001001??11111000?200?111???????0???0?????1?2020?3?1012?021??12????1001230311101221023001100111001210

Kimmerosaurus\_langhami

??1??0?1??0?0????????????0?????10??0??????20100000102000000011101010201101?101111111?????????????200?0????????0200110001000?002??0?00?01220???1?1001?01?00011??3?01100111???1?0???????????????????????????????????????????????????????????????????????????????????????????????

Pantosaurus\_striatus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100111?320??00???000100??1??110000?2000111?????????????????????????01001?021011200??10????0210101??1?1?10???211???1211

Picrocleidus\_beloclis

?????????????????????????????????????????????????????0????0?010??0?????????????10012??????????????????????????????1100?1000???2??2?????11?????1?1101?02411011223201200111000100111?011?0?0?200?101001011002010201201020201?01?12?021112200??101???02111012210110010011111?1?10

Tatenectes\_laramiensis

???????0?????????????????0??????0??????1????????????2000?0000??????????????????????????????????11????????0?1???????????????????????????11??????01001????00011??32011001?1000100?110?110000??????????1011???????01??1020101?10?110021011210??10????0210101??1?2?001?0211??01??1

Plesiosaurus\_mansellii

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1111101??2?1101???320??00?????01?01??1111?????1010011??0???????????2??1?202????????????????????????????????????????????2?????????

Colymbosaurus\_trochanterius

???????????????????????????????????????????????????????????????????????????????????????????????????????????????????100?1000??????0????????????1?1110??2410012??320?200111??01?01??1011??00?2010101??0???????????2??102?2???????????????201??10111?2210101221022101102?11101211

Djupedallia\_engeri

??????0?????0?????????????????????????????????????????????00???????0?01111????????????????????????????????????020??????????????????00?0??1??2011???100?510012113201200111030100110??1100??????????????11?0???0?0??01??????3????????????2?0??????1?02?0?012?1???101102???1?1211

Spitrasaurus\_spp

??????0?????0?????????????????????????????????????????0???00??1010?????????????1??????????????????0???????????0201?100?1000???2??0?00?01110?20111111??2521012213201200111030100110?01100??????????????11?0???0?0??01???2???????????????2?11?????1?02?0?012?1???101102?1???1?11

Abyssosaurus\_nataliae

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???1110??1?1001???3201200111??01?01??1011??0???0???????0010000100??2??10?0?001?1?1101110??2?1??1????10???10?22?0?3??110???1001211

Umoonasaurus\_demoscyllus

00000100112??1101020??00??00????0??????????0?002222?10???10?11????1??12?11?0??0??022?????0?????11122?1211000????????0??1111???????1111010?01????????????1001????20?1??1010??00?110101102000201?00?1???1?01?010?????????????0???????????21????0111?02001022210?2???1?0??10?1??1

Nichollssaura\_borealis

0000010011200010102010001100000100?000010010000122301010010011??211?2??0???00000?0221110101100011122?13110000?0111110??0101?112??02?1001010100100??20022100100132011?010??000??1102?101?00000?????????10110020??????????????2?12102?01?2??0000??1??200101?21012101100011101110

Leptocleidus\_capensis

010001?1112?1010102002001?0000?10??0000??01001022?201010?0??01??21?????0?????????0221110?01?00011122?12110001?????1110?0111???2?111111010101???????????210010??320?1?0100?0?0?0?????1??????????????????????????????????????????????????2????00????0???????????2???1?0??10?1???

Leptocleidus\_superstes

??0?0??1?1?0????10??????1??????????????????0?10222201010?100011121?0011?01???????02211???????????122??31????1???????????????????????????????????????????0?01?0132011001000??00?110?11102???1011001?10110011020??1?100200102??????????????????01???02001012?0??????????????????

Vectocleidus\_pastorum

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?01??0?1??1010??00??10??1102?????????????1???1?02???1??01?10?0????????????????????????????????????????????????????

Brancasaurus\_brancai

0010?000100000??101002001?00000?0?1000???0101?02223010?0?00?011101101120101000100022?????011000???0???????????01???100?1110???2??121100111?120100??20014100100232012?0101100000110101102000101?1011???1?01?0201?10?0?210?0201012102101121????0111002001022200321?11???110?1???

Gronausaurus\_wegneri

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?12?20?2001111?000?1110011100002011101????1????????????0?210???01012102101021????0112?02000022210?1???1?0????????1

Speeton\_clay\_plesiosaurian

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???????????2101012320120011110010011201111000?20?1111??1011?1??20??1??002?????010121011011200??00102103001022?1021001100011101?11

Wapuskanectes\_betsynichollsae

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1??1??0???????????2101?2?110?1110110?10??3????????????200???01???03000022???????????????????0

Futabasaurus\_suzukii

00??000?1?0?00??0??00?0?2?0000????????????????????0???1??????????????????????????????????0110000???????????????100??????0?????????100001100???????????????11?22?2022001111?010?11110111000??????????????????????????????01301?1??01?0?1100200000220300102221122101100011101?10

Callawayasaurus\_colombiensis

000010?0?10000??10100?0020?000?10????????01010000220101010001111011??02?1010??1?002211001????0?0???2?1100???1?1101??0??20?????2??010000110012??????????5210102232022001111?0100111211110???????????200100?11001120010?10?01?????????00??0???100?220300102?3101200?10?0111??2?1

Eromangasaurus\_australis

000000???10000??10200?0020?000??00?000010??0010???????101?0?11????????????????????2????????????0???????????????1011?????010????????000011001?01?1101??2?2101???3?0??????????1?0???????????????????????????????????????????????????????????????????????????????????????????????

Kaiwhekea\_katiki

00001010??000???1020020020?000?????????11????0?0?32?2111000?00????????????????????????????????????????????????0101?10??1000??????0300001120?2??????????51011122320?2?0111?10100?11111?10???2????0??????????????????????????????????????000??00??11?32?11??3?12110100?0012?1??0

Aristonectes\_parvidens

00?010??1?0000201??00200200000??00?????11??01010?3212?1?0000?00?1?01212010???????????????0?10000??????????????0101010??1000???????3000011200?1101101?02?1111???3???200111??01?0???????????????????????????????????????????????????????????????????????????????????????????????

Libonectes\_morgani

010010?011000020102002002000000?00110001001110??0?21??111?00010?010?20201010?00100221100101?00?0?122?1200???2101000101?2000?112000101001?0012???1?????1621?122?320?200111??01??1???????????????????21011??????11100?0?100?1?????????????00??00????????10??????200??01?1???????

Hydrotherosaurus\_alexandrae

000010?0??0000201?100?002??0000?0011000100111?????2121?111??01?????????????????????????????????????????????????100010?1?01??112???10000110012???1?????1521112223202200111?101001110011100002011?11?1001?00001011200?020????120111011000100?000??12031010123102300110?011101211

Edgarosaurus\_muddi

100101?021001020111010001??0?0??001000010?200102220011101000110?01?02?2?1?0????1002211?01??????10122?1300100201100011011110?120011?110111100?010100000121001?1132011201000000000???01????????????????????????????????????????????????????00?00??????0010?2?0?3?10??0101??01211

Plesiopleurodon\_wellesi

00010??0?100102?1120?000???2?0?????????????1???222201010?10?11????????????????????????????????????????????????0001?11???110?1????1?000210?0?????????????100?011320?120100?0?0?0??0??110?????0??101????????????20110?1?01??????????????????????????????1012?1??????????????????

Richmond\_pliosaur

00010120110011201120?000???2?0??00??01010??1???2222010101100111101?????????????1?022??001???00???1?2?100????1??001??????1???11????100011020?11101000?0210001?02320?1201001000100100?1100?00101010011??1???????20?1??????????20100121011200110110111200101221022101100011101?10

Stenorhynchosaurus\_munozi

0002012?21??00210??01001??002????1??00?????00????????????????0????????????????????12?0?0?11?100???2110310?????1?000010??001?1110?0?10101021?0??????????10002???3211?00?????01?????2????????????????20?1???2000??200??2??????????????10???0?101??010???101????32101102001211?01

Anguanax\_zignoi

??0?01?0?????????????????????????1???????????????????????????0?????????????????????????????????????????????????????11???01?????????????10?0????0????11??0?01?????0??10?????????????????????00??????????????????????????????????????????????????0??0???00??1????1?1?0?0????1??1

Makhaira\_rossica

0??????????????????????????????????????????????????????????????????????????????????????????????????????????????100??????????11????20??010?10????????????????????????????????????????11???????????????????????????????????????????1????????????????????????????????????????????

Luskhan\_itilensis

0102012??21100210??0?00001?000???1?0000100200?0023120100010??010??10?11?10?1?11??01??????????????12110????????10000110?0001?113??03000?1??2001101??01?010001112321120000002011201???010????0010001?00?1??021002020000201????0023?1??1??000?001010102001012?0033000?02010211?11

Palmulasaurus\_quadratus

00?2????????00????????00???????????????????????????????????????????????????????????????????????????????????????000??????????1?????1000211?01????????????????????????????????????1???11????????01???????????????????????????0101200210022100?01??120200101?20022101100011101211

Pahasapasaurus\_haasi

00020?2?2???00??1110??00???0????00?0?10????1??????????1?????????00?0???????1???1?02?1000?????0?0?12???200??????00???????????1?????2000211101111?100???2?1001???320???0?????0???????????????????????????????????????????????????????????2100101??110201100????1210??00011101?10

Polycotylus\_latipinnis

00120?20?1??102?1110100011?000???0??01010021???223210111010?111101???????????????01?11111000000111?2?120?1?10?1001?11011111?122011100011020011101002102200011113201120100100010010201110??01110000100?1000001020121012?11?1110100111113210??011?111200102221033101101011001211

Thililua\_longicollis

000210?0?10000201110??0011?000??001?010????1?????220??11??0?11?????????????????????????????????????????????????0000?????1???1?????100?111?0??0?????????31101??2320????????1?0??1???0??????????????????????????????????????????????????????????????????????????????????????????

Trinacromerum\_bentonianum

00020121?1?000211110100011?000???0??01010021???1?31?11110???01??0????12010???????01311111??????11122?13001?00??001?11???10??12???1?000211200?1101000?02?00012??3201?201000?00?00????11??????1?000???11101120?0201010020110111?110?111?32????0?????1???10?2???33?0??01011001211

Dolichorhynchops\_osborni

0012012011000020111010000110001?001001010021???22311?1110100110?01102?201001?01100131111100100011122?01001010?1000011011101?120011100021120?011010001021000101232011?010000001001120110?0000???11??101101000002011100201101110110121113210100000101200102211033101101011001?11

Dolichorhynchops\_bonneri

00120120100000210??010000110001?001001010021???223010111010?110??1?0?1?????1?????01311??10??00?11122?0200100??10000010111?101220101000111200?110120010110001111320?120100?000?10?1101100??001??100?101101?002020111?02??101110110?110?12100101??111300102231033101101011001?11

Pliosaurus\_almanzaensis

?????????2????????????????????????????????????????????????????0?20????????????????121????1?00010?121?03?0?????1?11?01???000?12?0??????????1?????????????000????1?0???????????????????????????????????????????????????????????????????????????????????0???2????3???1?1??1??????

Pliosaurus\_patagonicus

???????????????????????????????????????????????????????????????????????????????????????????0?01???????????????111?0?????0???10?0????????0?1???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Rhaeticosaurus\_mertensi

????????????????????????????????????????????????????????????????????????????????????????????????????????????????11???????11?00???0?????0??0?2??????????31001[12]??1?0?2?0100001000??11?1000000[12]0??00???????????????????????????01000111000????100??1200010?1?0??1200?0?0?100????0

;

ccode + 3 6 8 9 14 21 24 27 28 37 42 47 48 49 51 52 62 64 67 68 70 83 98 102 111 125 130 136 137 140 150 151 152 158 159 160 163 174 177 178 183 186 187 189 195 204 206 207 223 226 230 231 233 234 240 241 243 244 248 249 250 253 254 260 261 264 267;

proc/;

**4. Second run of ‘ordered’ parsimony analysis (2ndOPA)**

xread

'Exported from NEXUS Data Editor'

270 99

Yunguisaurus\_liae

0001000??10000000??0010010?000010010?000?000110??200??00?????01020???????????????02?10???????0?0?0010020???10011001100?1001?1????13??0??????1??????????41000??00?000000?001??0??01210?0?00???0??????0?000?200????????????0?00122011?0000002000??11000?000?0?000000010000100000

Pistosaurus\_postcranium

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????20011100000000000110100101100010????101110?00?001?202100??0??001????0122210???1??????01?1?00000000???0???0?10????????0

Pistosaurus\_skull

010100?0010000000??001001000000?10000001000001001200?000????0010?0???????????????02??00000??0000?0010020????20?????????????????????0100??00???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Augustasaurus\_hagdorni

010100?0010?00000??00100100000000000000100?0010012101000010??????0???0?0000??????02??000?0110000?0010000????0?1100?10??1001??1???01010002100???00??21??41?01??000000200?0?10000011??0000???????????00?000?102?020000?0?????????????????000??00???100000000???0?100?1000???0?00

Bobosaurus\_forojuliensis

????????????????0??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????02?0?00?00??01?2100000??110?12?000?00??001221100?10?1????????????????????????????????0122010?001??????0???1?000????????0???0?0??0??????

Macroplata\_tenuiceps

1101001??10?10101110??001??1001010?0???????0010????0?????????010100?012?100??01?100211???????????100??00??????1111??0??21???11??00201001110000100??210220001???110?120100??30?001?11100000?0110000?20110?1????0000000?001?0001?2012?002?????0?101?0?0?0?0?110?1???010??01?????

Anningasaura\_lymense

111000?0120?00??10000100?0010000100000?10000010112001000?10?0?1020?0110111010010?00211?1000000011?00?000?111??1110?100?1010?110??00010011000?0?00??0?0??10010??3?0?120100?031?1???????????????????????????????????????????????????????????????????????????????????????????????

Stratesaurus\_taylori

001000?0100100100??0110010000010?0?000010000010001001000010101101012002000010?00102211???01000010110?000000?2?111?11000110001?0?001000011000?0?00??2001?10010011100120100003101??1????00?0????????????1?????????????????????01022111??????????????????????????1???010??010??10

Avalonnectes\_arturi

??????????01??10????????10?????01??00001000001001100100001010???????????????????1??????0???????????????????????????????????????????????????????????????2100?00211001??100?0110001101101200?0110?00????1?01201???????????????0102?110??1?????????11020?000?110110?101000010?100

Eurycleidus\_arcuatus

???????????????????????????????????????????????????????????????????????????????????????????????????????????????111??????????1?????????01110?????????????100100211000201000010100?1?1101????0110100?201101120010201000100?10001020110001??????0101?02110010110????1?10????????0

Meyerasaurus\_victor

10?00?0?21??00??11??0100??0000???0??????????????????10?0??0101???0????????0??????022?0?1?01010111122?11000101?0111100?02110211???01?1001010?0???0???1?120?01?????00?20????0???0011211012002?110?0?0111?0?1????0201000?0001000102011?0011002100??12020?00021??11011010001101100

Maresaurus\_coccai

110100?1220?1???1120?1001?0?00?????????????00001120?10???10?0110?0?????0?????????0??11?000101010?122?1000???200111?00??2100?11???01?1?011100????0???????0001???2?0????1???030?????????????????????????????????????????????????????????????????????????????????????????????????

Borealonectes\_russelli

11010?1?210?102011100?00?0?0000??010?0010010000????1?000??0?0???20???12000???????022?1?0???????0??2???201?????111??00???1?0?110??0??1?01?10?00100??21?120001???2?0??20?????30?0????????1???????????????????????????????????????????????100??00?????1101012???2?011?0001???11?1

Atychodracon\_megacephalus

100101212201121010002100100100?000?000010000010012001000110101???0?201?000???0??1002111000100011011???00?0002001111?0??20?0?11??0??00001020?0???0???10120001???1100?201????10?00111?1012001??20?0?0??????????1??????????????01022110????????00??1?0201001?110?1??1010??0?????0

Archaeonectrus\_rostratus

1002002???0?102?1111??00?????????0?000?10000010012011000?1??01?????????????????????????????????????????????????11??1????1?????????????11120?0??????????2100100111000201???0?11?0110110110010??????0?????0?20?1??????????????01?2?1100?10001000??1?020?00??11011011010001101100

Rhomaleosaurus\_cramptoni

10000021220?1020100121101?00001?1000000???0001001201100011110?10?0???1?000???????02?1110?01010110122?1000000200?11?00??2100?11???01?1?01020?00?????????200???1211000??1?0?01?1?0002110?100?0????0?????1??????????????1??????0102?11000?10???00??1?021?001?1??110110100?11?1?00

Rhomaleosaurus\_zetlandicus

11000??1220?102010012110??00001??000???????001001?0110?0?1110110?????1?0?0????????2211??0?1????1?1?2??0??0??2001111000021002110000??1001020?0??????????200010??110?020100?010?00??2110?1???01201000????????????????????????????????????1?0??001212021000121101101101001?????0?

Rhomaleosaurus\_thorntoni

11??0???2?0?10??1021?1101?00?????0??0001000?????????????1?????????????????????????????1??01??01?????????????200111??10?11???11000?11100101000???????????0001???110?000100??10??01?21101?00?0110100??01100120210?0?000100?10001220110001??????0111?02100002110?????????????????

Thalassiodracon\_hawkinsii

00100001110100111120??0?1000???0000000?10020000001011000010110101010002000011000101011?00011001??100?000????0?11101100010000?1200?001001110010000??2101310010011100120100002100011101000001011000002011011001?00000001000?0001020111001000200000110100000010?11001010000101100

Hauffiosaurus\_longirostris

00?20??0?1??12111120??00???2????????????????????02???????????01001??0???1?0?????1110?????????????110?0??0?????1001?100?1100?11?0023010011200??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Hauffiosaurus\_tomistomimus

00020?10210?1?110??0100?0?0210100100???????00?00010100?0?101?01011??????1001????111011?0?0100010?100?010??????1000?100?1100?112002301001120?1100?????1231001?11110?100100002000011101010001??10???0???1??1?0?0????????????00????????00???0?1000012010000121?01101?1?0?11201?00

Hauffiosaurus\_zanoni

00?2??1??1??????????????0?0??????????0?10???????????00?001???010????????????????11101101?0100010?100?010????20100??100?1100??12002301?01120000?00??????310011?11100100100?020?00?????????0?01100000201101120??0020000?010?0001020?2?0001001000??11010?00121??11011010001101100

Marmornectes\_candrewi

0???????????00??0?????00???????????????????????0????10???0???0????????????????????????????????????????????????10100110?0000?111000201021020000000??21?1?0001???1200100100?200?1001??1?00?1?0010000??????1?0??000?00???00????00220111??2000??00110001000012100?1??1110??011???1

Peloneustes\_philarchus

10020120211100210??010001000101?010000010020010003121100010?00101100011000011?10102211100110?010?12110200???2110110110000001111000211001020001000??21?110001?121200110100000011001201100?1?0010001?00?1011000010000002000??1002301111022000?01??000210001220022101110111111111

Simolestes\_vorax

110101???21?10210??010001??010??0100000100200?0003111?000?0?0010110??11000????1???221110???????0?121?0210???210111??10?0000?111000??1?01010?0??00???111100011121?0?1000001200110????11?????0????0??20?10012010?02?000?0????000230??1102201??010100021010122001110111001111????

Pliosaurus\_funkei

???????0?????0????????????????????????????????????????????????2?2??????????????????????????????????????????????????01????00?1????0????010?11????????????0001???1????00???0?00?2?00??1100??????????????????????2000000200?????????????????0??0?0????2?01012???3?101?0101???1??1

Pliosaurus\_westburyensis

110101?0221110210??010011000011?1100000100200100231111000201002020???1????0????0?0121110011??????12110210???1?101?0010?200???13000?01011011?????????????0001???1?00?00?????00???00??1100??????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_carpenteri

11010????2??10210??0??011?00???????????????00?00231111???20?002020??????????????????11?00110?010??2110?1??????1011??10??0?0?1110002111010111???0????1?0?0001?0?1?0?1000000200120?0??110????????????1??1?0?2000?????0?2?0???????????????2????00????1???10?????3310?1?1011?11??1

Pliosaurus\_brachydeirus

11?1?????2??102?0??01001???0???????????????00?0???1??????????02020?????????????0?????????1?????0?12110310?????101??010?2000??13000?011010?1?0???????????0001???120??10???0?00?2010??1100????????????????????????????????????????????????0???00????0?????1?1??23???1?1??10????1

Pliosaurus\_macromerus

1101????22??10210??0??011?0????????????????00?0???1??????????0???0?????????????00022111001100010?12110310?????1011??10??000?11300010110101?1??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_brachyspondylus

???1?????????????????????????????????????????????????????????0????????????????????????????????????????????????1011?010??000?113000????01011?010?????1?010001???120??00?????01?20??20???????????????1??1??0???0???????200?????????????????????0110?02101012100????????????????1

Pliosaurus\_cf\_kevani

?????????????0???????????????????????????????????????????????????????????????????????????????????????????????????????????0????????????010?2?????????????0001???1?0??00???0?00?2?00??11??????????????0?1????????020000200???0002300111032????00??001?10101210023101101?11011211

Pliosaurus\_kevani

110101?022??10210??010011000011?1100?0010020010023021100020?00202000011010?0??10?022111001100010??????????????10??0010021001113?002111010?21??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Gallardosaurus\_iturraldei

??0?01?022?1??21????????10??????11?0000100200100?3121100020?011021???1????????????121110???0?010?12110310???211?????1???0?????????????????2????00??2111?00011??1?0?110?0??20??????????????????????????????????????????????????????????????????????????????????????????????????

Pliosaurus\_rossicus

11?1?1??????10210??01001??????1?11000001??200?0??3111??????????????????????????????????????????????????????????1????????0?????????1?1?01011???????????????????????????????????????????????????????????1000200?2????0?2????????????????????????????????????????????????????????

Pliosaurus\_irgisensis

???????0??????21????????????????11?0000100200?0?231?11?002??0???2????1??????????????????????????????????????????????????????????????????????????????????000??1?1?0?1??000?200???????????????????????????????????????????????????????????001?0?????0???10??1???3???1????1?111??

Pliosaurus\_andrewsi

01020?2021??10210??0??00??00???????????????00?00?3?211?0??0?00??11??????????????102?11?00110?010?1211020????21111?0110000101111000211001010001001102??210001012110010000002001100120110??1?0010000??????????????????????????00230110???200??01??02021010122003210?100011011211

Liopleurodon\_ferox

11010120221110210??010001000101?11?0000100200000031211000?0100101100?1100001??101022111001101110?12110210???2111110010?0010?111000111101010001100??0110100011121200100101000011000?0110????2010100????1??0?000?????0??01???1????????10320???010???02101012?0?2?101?0001???1?11

Kronosaurus\_queenslandicus

??0?0?20?1??????0?????????????????????????????????????????01000???00011000?01110?111?0???????????12110?10??????????0????001????0??????01010?011?0??2??00000?11?3211?0?000?0001??0?20?1??0??2?10000?00?10?0?????02??0020????1????????103??????????????????????????????????1????

DORK\_G\_1\_2

?????????????0?????????????????????????????00100231210???20?0?????????????????????????????????????????????????????????????????????????110?0???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Megacephalosaurus\_eulerti

010200?0211100210??110000010210?111000010120010023121000120?00???????????????????011???00011000101211031010?2111000010?0001?1110000000110000???????????????????1??????????????????????????????????????????????????????????????????????????????????????????????????????????????

Brachauchenius\_lucasi

00020120211100210??010001000210?111?0001012001000312100012??00???????????????????011?0100?1011?0??2100310???211???001?00001?11?????????10?0?0???0?????000002????211?00?????????00??001???????????????????????????????????????????????????????????????????????????????????11111

Brachauchenius\_MNA\_V9433

0102?????1?100210??0100010?0????????0001???00?002?1210?0?20?0????0?????????????????????00????110??2110210???2111000010?0001?1110000000110000???????????0000211?3211100000?200?2?0???01??????????????0?1???????22200002?????11??0011?10????????????????????????????????????????

QM\_f51291

????01??2?????210??010?????0210?1110000????0010???12?????????????????????????????????0?00????????????????????????????????????????????????10???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Attenborosaurus\_conybeari

00010010???110??112???0010?0?????0??0001002??????2??10000???11??????????????????1?2???????????????????????????0110??0???0?????????10100???0?2??????????310??011110????1???0?00??11101100?0???1???1?20?10?1????0220000?000?310?02??1?0010001000??1??10?00?????1?001?100???01101

Plesiosaurus\_dolichodeirus

001100?0110?00100??0010010?000010010000100?001000100100001010110?010?02000?1111?10?01100?01000110100?000?1110?0100?100?1000???????100001110?2???0????01410010121?00100101003?00011111100001000010??211101100110000000?000?000002012100100020000?1102010000200110?1010000?01100

Eoplesiosaurus\_antiquior

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2??????????4100?0111?0?12?1???03??0??????????01000?11?02??1001002?0?0??00???????0??2?11?00110020000?11010100??1?0110?1010000101100

Eretmosaurus\_rugosus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100110?100?12010000?000111??11?0???0000?01????1?????????0??0???????0010201200011000000??11021?100020011011010000201100

Westphaliasaurus\_simonsensii

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2????????????0011021?0??0010?1031000111?1?0010?0000101?211100120??00000001??10000??20?20001?????00011002100011100110110100011?1??1

Seelyosaurus\_guilelmiimperatoris

00000?00?10?02?????0???????0?????0??0011001????1?1?01000?0??11?????????????????????????????????????????????????10??100?1010???????100001100?2??????????3100?1221000???1???00?00?1200110010?100001101101001201?10030?1?0???300?02??200011000100??11020?100?20011011000011201101

Microcleidus\_tournemirensis

0000000?120102100??0010010000000001011110010010002001000110?1????1?????000?????0112?110000??00?0?12100100???20????????????????????11000110012?????????142101112100?20?100?0010011200111010?????????201100120211013010?010?300122012000110????0??1?020?100?2?0110110100012?1??1

Microcleidus\_brachypterygius

0011000?110102100??0010010000000101011110010010102001000100?????1???????????????101??100?0010000?12100000???20?????????????????????0000110012?????????2321011121?00??1????00100?12011110?03100011?0210???1????20130?0?01???101220?10??01002000??11021?100?2??11010010011101101

Microcleidus\_homalospondylus

0000000011010210???0010020?000?010?0111100100101020010001??11110110010200001??001021?1?00????000??2100100???2001001??00?0???102???10000??0012??????????42101112100020110010010011201111010?1000011??1011110001?01?010101???00122012000010?20000011021?100110011011010011201101

Plesiopterys\_wildi

00100?0?1???00????????00???00??1?0?0???10??01?0001001000?00?0?10101110200001001010110???1????0011?00??00?100???20??100?1000?0?2??0?00?01110??????????02420011121101?001??0001001111?1100003000000?01?11?01201??0??0???010?3?0102012?001???00?000110200101?2??11001010011101110

Cryptoclidus\_eurymerus

00100?0010?101100??00100101000010000020100201001011010000000010?1011101101?111011111??00101100011?00?0????000?02001100?1000?0021?0200001110121111101?013100111232011001110000000111011000000010001121011001010201201020200?1100210110112010?101113032010122101300110?2??001211

Tricleidus\_seeleyi

01100???????011010?00?0010?000?100?????????01001?3001000?000010?00?0111111?????111110?????????011200?000?1100?0201110001000?0021?01110011001?11?1101?02210011123201100111000100?11?01100???????????110110000002012010202?13????????????210??1011130210101221023001101111101211

Muraenosaurus\_leedsii

00????????0?01100??001001??000?10??????????010?0?????1???0???10?00?0????11?????11011??????????????0???????????0201010002000?0021?010100110012?1?1101??14210112232012001110001001??11111000?200?111???????0???0?????1?2020?3?1012?021??12????1001230311101221023001100111001210

Kimmerosaurus\_langhami

??1??0?1??0?0????????????0?????10??0??????20100000102000000011101010201101?101111111?????????????200?0????????0200110001000?002??0?00?01220???1?1001?01?00011??3?01100111???1?0???????????????????????????????????????????????????????????????????????????????????????????????

Pantosaurus\_striatus

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????100111?320??00???000100??1??110000?2000111?????????????????????????01001?021011200??10????0210101??1?1?10???211???1211

Picrocleidus\_beloclis

?????????????????????????????????????????????????????0????0?010??0?????????????10012??????????????????????????????1100?1000???2??2?????11?????1?1101?02411011223201200111000100111?011?0?0?200?101001011002010201201020201?01?12?021112200??101???02111012210110010011111?1?10

Tatenectes\_laramiensis

???????0?????????????????0??????0??????1????????????2000?0000??????????????????????????????????11????????0?1???????????????????????????11??????01001????00011??32011001?1000100?110?110000??????????1011???????01??1020101?10?110021011210??10????0210101??1?2?001?0211??01??1

Plesiosaurus\_mansellii

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1111101??2?1101???320??00?????01?01??1111?????1010011??0???????????2??1?202????????????????????????????????????????????2?????????

Colymbosaurus\_trochanterius

???????????????????????????????????????????????????????????????????????????????????????????????????????????????????100?1000??????0????????????1?1110??2410012??320?200111??01?01??1011??00?2010101??0???????????2??102?2???????????????201??10111?2210101221022101102?11101211

Djupedallia\_engeri

??????0?????0?????????????????????????????????????????????00???????0?01111????????????????????????????????????020??????????????????00?0??1??2011???100?510012113201200111030100110??1100??????????????11?0???0?0??01??????3????????????2?0??????1?02?0?012?1???101102???1?1211

Spitrasaurus\_spp

??????0?????0?????????????????????????????????????????0???00??1010?????????????1??????????????????0???????????0201?100?1000???2??0?00?01110?20111111??2521012213201200111030100110?01100??????????????11?0???0?0??01???2???????????????2?11?????1?02?0?012?1???101102?1???1?11

Abyssosaurus\_nataliae

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???1110??1?1001???3201200111??01?01??1011??0???0???????0010000100??2??10?0?001?1?1101110??2?1??1????10???10?22?0?3??110???1001211

Umoonasaurus\_demoscyllus

00000100112??1101020??00??00????0??????????0?002222?10???10?11????1??12?11?0??0??022?????0?????11122?1211000????????0??1111???????1111010?01????????????1001????20?1??1010??00?110101102000201?00?1???1?01?010?????????????0???????????21????0111?02001022210?2???1?0??10?1??1

Nichollssaura\_borealis

0000010011200010102010001100000100?000010010000122301010010011??211?2??0???00000?0221110101100011122?13110000?0111110??0101?112??02?1001010100100??20022100100132011?010??000??1102?101?00000?????????10110020??????????????2?12102?01?2??0000??1??200101?21012101100011101110

Leptocleidus\_capensis

010001?1112?1010102002001?0000?10??0000??01001022?201010?0??01??21?????0?????????0221110?01?00011122?12110001?????1110?0111???2?111111010101???????????210010??320?1?0100?0?0?0?????1??????????????????????????????????????????????????2????00????0???????????2???1?0??10?1???

Leptocleidus\_superstes

??0?0??1?1?0????10??????1??????????????????0?10222201010?100011121?0011?01???????02211???????????122??31????1???????????????????????????????????????????0?01?0132011001000??00?110?11102???1011001?10110011020??1?100200102??????????????????01???02001012?0??????????????????

Vectocleidus\_pastorum

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?01??0?1??1010??00??10??1102?????????????1???1?02???1??01?10?0????????????????????????????????????????????????????

Brancasaurus\_brancai

0010?000100000??101002001?00000?0?1000???0101?02223010?0?00?011101101120101000100022?????011000???0???????????01???100?1110???2??121100111?120100??20014100100232012?0101100000110101102000101?1011???1?01?0201?10?0?210?0201012102101121????0111002001022200321?11???110?1???

Gronausaurus\_wegneri

??????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????01?12?20?2001111?000?1110011100002011101????1????????????0?210???01012102101021????0112?02000022210?1???1?0????????1

Speeton\_clay\_plesiosaurian

????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????2???????????2101012320120011110010011201111000?20?1111??1011?1??20??1??002?????010121011011200??00102103001022?1021001100011101?11

Wapuskanectes\_betsynichollsae

?????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????1??1??0???????????2101?2?110?1110110?10??3????????????200???01???03000022???????????????????0

Futabasaurus\_suzukii

00??000?1?0?00??0??00?0?2?0000????????????????????0???1??????????????????????????????????0110000???????????????100??????0?????????100001100???????????????11?22?2022001111?010?11110111000??????????????????????????????01301?1??01?0?1100200000220300102221122101100011101?10

Callawayasaurus\_colombiensis

000010?0?10000??10100?0020?000?10????????01010000220101010001111011??02?1010??1?002211001????0?0???2?1100???1?1101??0??20?????2??010000110012??????????5210102232022001111?0100111211110???????????200100?11001120010?10?01?????????00??0???100?220300102?3101200?10?0111??2?1

Eromangasaurus\_australis

000000???10000??10200?0020?000??00?000010??0010???????101?0?11????????????????????2????????????0???????????????1011?????010????????000011001?01?1101??2?2101???3?0??????????1?0???????????????????????????????????????????????????????????????????????????????????????????????

Kaiwhekea\_katiki

00001010??000???1020020020?000?????????11????0?0?32?2111000?00????????????????????????????????????????????????0101?10??1000??????0300001120?2??????????51011122320?2?0111?10100?11111?10???2????0??????????????????????????????????????000??00??11?32?11??3?12110100?0012?1??0

Aristonectes\_parvidens

00?010??1?0000201??00200200000??00?????11??01010?3212?1?0000?00?1?01212010???????????????0?10000??????????????0101010??1000???????3000011200?1101101?02?1111???3???200111??01?0???????????????????????????????????????????????????????????????????????????????????????????????

Libonectes\_morgani

010010?011000020102002002000000?00110001001110??0?21??111?00010?010?20201010?00100221100101?00?0?122?1200???2101000101?2000?112000101001?0012???1?????1621?122?320?200111??01??1???????????????????21011??????11100?0?100?1?????????????00??00????????10??????200??01?1???????

Hydrotherosaurus\_alexandrae

000010?0??0000201?100?002??0000?0011000100111?????2121?111??01?????????????????????????????????????????????????100010?1?01??112???10000110012???1?????1521112223202200111?101001110011100002011?11?1001?00001011200?020????120111011000100?000??12031010123102300110?011101211

Edgarosaurus\_muddi

100101?021001020111010001??0?0??001000010?200102220011101000110?01?02?2?1?0????1002211?01??????10122?1300100201100011011110?120011?110111100?010100000121001?1132011201000000000???01????????????????????????????????????????????????????00?00??????0010?2?0?3?10??0101??01211

Plesiopleurodon\_wellesi

00010??0?100102?1120?000???2?0?????????????1???222201010?10?11????????????????????????????????????????????????0001?11???110?1????1?000210?0?????????????100?011320?120100?0?0?0??0??110?????0??101????????????20110?1?01??????????????????????????????1012?1??????????????????

Richmond\_pliosaur

00010120110011201120?000???2?0??00??01010??1???2222010101100111101?????????????1?022??001???00???1?2?100????1??001??????1???11????100011020?11101000?0210001?02320?1201001000100100?1100?00101010011??1???????20?1??????????20100121011200110110111200101221022101100011101?10

Stenorhynchosaurus\_munozi

0002012?21??00210??01001??002????1??00?????00????????????????0????????????????????12?0?0?11?100???2110310?????1?000010??001?1110?0?10101021?0??????????10002???3211?00?????01?????2????????????????20?1???2000??200??2??????????????10???0?101??010???101????32101102001211?01

Anguanax\_zignoi

??0?01?0?????????????????????????1???????????????????????????0?????????????????????????????????????????????????????11???01?????????????10?0????0????11??0?01?????0??10?????????????????????00??????????????????????????????????????????????????0??0???00??1????1?1?0?0????1??1

Makhaira\_rossica

0??????????????????????????????????????????????????????????????????????????????????????????????????????????????100??????????11????20??010?10????????????????????????????????????????11???????????????????????????????????????????1????????????????????????????????????????????

Luskhan\_itilensis

0102012??21100210??0?00001?000???1?0000100200?0023120100010??010??10?11?10?1?11??01??????????????12110????????10000110?0001?113??03000?1??2001101??01?010001112321120000002011201???010????0010001?00?1??021002020000201????0023?1??1??000?001010102001012?0033000?02010211?11

Palmulasaurus\_quadratus

00?2????????00????????00???????????????????????????????????????????????????????????????????????????????????????000??????????1?????1000211?01????????????????????????????????????1???11????????01???????????????????????????0101200210022100?01??120200101?20022101100011101211

Pahasapasaurus\_haasi

00020?2?2???00??1110??00???0????00?0?10????1??????????1?????????00?0???????1???1?02?1000?????0?0?12???200??????00???????????1?????2000211101111?100???2?1001???320???0?????0???????????????????????????????????????????????????????????2100101??110201100????1210??00011101?10

Polycotylus\_latipinnis

00120?20?1??102?1110100011?000???0??01010021???223210111010?111101???????????????01?11111000000111?2?120?1?10?1001?11011111?122011100011020011101002102200011113201120100100010010201110??01110000100?1000001020121012?11?1110100111113210??011?111200102221033101101011001211

Thililua\_longicollis

000210?0?10000201110??0011?000??001?010????1?????220??11??0?11?????????????????????????????????????????????????0000?????1???1?????100?111?0??0?????????31101??2320????????1?0??1???0??????????????????????????????????????????????????????????????????????????????????????????

Trinacromerum\_bentonianum

00020121?1?000211110100011?000???0??01010021???1?31?11110???01??0????12010???????01311111??????11122?13001?00??001?11???10??12???1?000211200?1101000?02?00012??3201?201000?00?00????11??????1?000???11101120?0201010020110111?110?111?32????0?????1???10?2???33?0??01011001211

Dolichorhynchops\_osborni

0012012011000020111010000110001?001001010021???22311?1110100110?01102?201001?01100131111100100011122?01001010?1000011011101?120011100021120?011010001021000101232011?010000001001120110?0000???11??101101000002011100201101110110121113210100000101200102211033101101011001?11

Dolichorhynchops\_bonneri

00120120100000210??010000110001?001001010021???223010111010?110??1?0?1?????1?????01311??10??00?11122?0200100??10000010111?101220101000111200?110120010110001111320?120100?000?10?1101100??001??100?101101?002020111?02??101110110?110?12100101??111300102231033101101011001?11

Pliosaurus\_almanzaensis

?????????2????????????????????????????????????????????????????0?20????????????????121????1?00010?121?03?0?????1?11?01???000?12?0??????????1?????????????000????1?0???????????????????????????????????????????????????????????????????????????????????0???2????3???1?1??1??????

Pliosaurus\_patagonicus

???????????????????????????????????????????????????????????????????????????????????????????0?01???????????????111?0?????0???10?0????????0?1???????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????????

Rhaeticosaurus\_mertensi

????????????????????????????????????????????????????????????????????????????????????????????????????????????????11???????11?00???0?????0??0?2??????????31001[12]??1?0?2?0100001000??11?1000000[12]0??00???????????????????????????01000111000????100??1200010?1?0??1200?0?0?100????0

;

ccode + 3 6 8 9 14 21 24 27 28 37 42 47 48 49 51 52 62 64 67 68 70 83 98 102 111 125 130 136 137 140 150 151 152 158 159 160 163 174 177 178 183 186 187 189 195 204 206 207 223 226 230 231 233 234 240 241 243 244 248 249 250 253 254 260 261 264 267;

proc/;