portal-phylogenies.Rmd

Marcos Padilla-Ruiz

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add intro to ape

```
install.packages("ape")
```

```
library(ape)
portal_tree <- read.tree(file = "../raw_data/portal-tree.tre")
portal_tree
```

```
##
## Phylogenetic tree with 43 tips and 345 internal nodes.
##
## Tip labels:
##   Sigmodon_ochrognathus, Sigmodon_hispidus, Sigmodon_fulviventer, Neotoma_albigula, Onychomys_leucoga
## Node labels:
##    Amniota, Mammalia, 'Theria (subclass in Deuterostomia)', 'Eutheria (in Deuterostomia)', Boreoeuther
##
## Rooted; no branch lengths.
```

read tre from url

```
small_tree <- read.tree(file = "http://ape-package.ird.fr/APER/APER2/primfive.tre")
small_tree
```

```
##
## Phylogenetic tree with 5 tips and 4 internal nodes.
##
## Tip labels:
##    Homo, Pongo, Macaca, Ateles, Galago
##
## Rooted; includes branch lengths.
```

the structure of a tree in R

```
class(portal_tree)
```

```
## [1] "phylo"
```

```
length(portal_tree)
```

```
## [1] 4
```

```
colnames(portal_tree)
```

```
## NULL
```

```
names(portal_tree)
```

```
## [1] "edge"       "Nnode"      "node.label" "tip.label"
```

```
portal_tree$Nnode
```

```
## [1] 345
```

```
portal_tree["tip.label"]
```

```
## $tip.label
##  [1] "Sigmodon_ochrognathus"        "Sigmodon_hispidus"
##  [3] "Sigmodon_fulviventer"         "Neotoma_albigula"
##  [5] "Onychomys_leucogaster"        "Onychomys_torridus"
##  [7] "Peromyscus_maniculatus"       "Peromyscus_leucopus"
##  [9] "Peromyscus_eremicus"          "Reithrodontomys_fulvescens"
## [11] "Reithrodontomys_montanus"     "Reithrodontomys_megalotis"
## [13] "Baiomys_taylori"              "Chaetodipus_intermedius"
## [15] "Chaetodipus_penicillatus"     "Chaetodipus_baileyi"
## [17] "Chaetodipus_hispidus"         "Perognathus_flavus"
## [19] "Dipodomys_ordii"              "Dipodomys_merriami"
## [21] "Dipodomys_spectabilis"        "Xerospermophilus_spilosoma"
## [23] "Xerospermophilus_tereticaudus" "Ammospermophilus_harrisii"
## [25] "Sylvilagus_audubonii"         "Campylorhynchus_brunneicapillus"
## [27] "Ammodramus_savannarum"        "Kieneria_fusca"
## [29] "Pipilo_chlorurus"             "Pooecetes_gramineus"
## [31] "Zonotrichia_leucophrys"       "Spizella_breweri"
## [33] "Amphispiza_bilineata"         "Calamospiza_melanocorys"
## [35] "Zenaida_macroura"             "Callipepla_squamata"
## [37] "Crotalus_viridis"             "Crotalus_scutulatus"
## [39] "Sceloporus_undulatus"         "Sceloporus_clarkii"
## [41] "Gambelia_sila"                "Aspidoscelis_uniparens"
## [43] "Aspidoscelis_tigris"
```

```
head(portal_tree[[3]])
```

```
## [1] "Amniota"
## [2] "Mammalia"
## [3] "'Theria (subclass in Deuterostomia)'"
## [4] "'Eutheria (in Deuterostomia)'"
## [5] "Boreoeutheria"
## [6] "Euarchontoglires"
```

```
summary(portal_tree)
```

```
##
## Phylogenetic tree: portal_tree
##
##    Number of tips: 43
##    Number of nodes: 345
##    No branch lengths.
##    No root edge.
##    First ten tip labels: Sigmodon_ochrognathus
##                          Sigmodon_hispidus
##                          Sigmodon_fulviventer
##                          Neotoma_albigula
##                          Onychomys_leucogaster
##                          Onychomys_torridus
##                          Peromyscus_maniculatus
##                          Peromyscus_leucopus
##                          Peromyscus_eremicus
##                          Reithrodontomys_fulvescens
##    First ten node labels: Amniota
##                           Mammalia
##                           'Theria (subclass in Deuterostomia)'
##                           'Eutheria (in Deuterostomia)'
##                           Boreoeutheria
##                           Euarchontoglires
##                           mrcaott42ott30082
##                           Glires
##                           mrcaott42ott29157
##                           Rodentia
```

```
str(portal_tree)
```

```
## List of 4
##  $ edge      : int [1:387, 1:2] 44 45 46 47 48 49 50 51 52 53 ...
##  $ Nnode     : int 345
##  $ node.label: chr [1:345] "Amniota" "Mammalia" "'Theria (subclass in Deuterostomia)'" "'Eutheria (i
##  $ tip.label : chr [1:43] "Sigmodon_ochrognathus" "Sigmodon_hispidus" "Sigmodon_fulviventer" "Neotoma
##  - attr(*, "class")= chr "phylo"
##  - attr(*, "order")= chr "cladewise"
```

```
class(portal_tree$edge)
```

```
## [1] "matrix" "array"
```

```
portal_tree$edge
```

```
##        [,1] [,2]
##   [1,]   44   45
##   [2,]   45   46
##   [3,]   46   47
##   [4,]   47   48
```

```
##  [5,]    48   49
##  [6,]    49   50
##  [7,]    50   51
##  [8,]    51   52
##  [9,]    52   53
## [10,]    53   54
## [11,]    54   55
## [12,]    55   56
## [13,]    56   57
## [14,]    57   58
## [15,]    58   59
## [16,]    59   60
## [17,]    60   61
## [18,]    61   62
## [19,]    62   63
## [20,]    63   64
## [21,]    64   65
## [22,]    65   66
## [23,]    66   67
## [24,]    67   68
## [25,]    68   69
## [26,]    69   70
## [27,]    70   71
## [28,]    71   72
## [29,]    72   73
## [30,]    73    1
## [31,]    72   74
## [32,]    74   75
## [33,]    75    2
## [34,]    71   76
## [35,]    76    3
## [36,]    65   77
## [37,]    77   78
## [38,]    78   79
## [39,]    79   80
## [40,]    80   81
## [41,]    81   82
## [42,]    82   83
## [43,]    83   84
## [44,]    84    4
## [45,]    77   85
## [46,]    85   86
## [47,]    86   87
## [48,]    87   88
## [49,]    88   89
## [50,]    89   90
## [51,]    90   91
## [52,]    91    5
## [53,]    90    6
## [54,]    88   92
## [55,]    92   93
## [56,]    93   94
## [57,]    94   95
## [58,]    95   96
```

```
##  [59,]   96   97
##  [60,]   97   98
##  [61,]   98   99
##  [62,]   99    7
##  [63,]   95  100
##  [64,]  100    8
##  [65,]   93  101
##  [66,]  101  102
##  [67,]  102  103
##  [68,]  103  104
##  [69,]  104  105
##  [70,]  105    9
##  [71,]   87  106
##  [72,]  106  107
##  [73,]  107  108
##  [74,]  108  109
##  [75,]  109   10
##  [76,]  108  110
##  [77,]  110  111
##  [78,]  111   11
##  [79,]  110  112
##  [80,]  112  113
##  [81,]  113  114
##  [82,]  114  115
##  [83,]  115   12
##  [84,]   86  116
##  [85,]  116  117
##  [86,]  117   13
##  [87,]   56  118
##  [88,]  118  119
##  [89,]  119  120
##  [90,]  120  121
##  [91,]  121  122
##  [92,]  122  123
##  [93,]  123  124
##  [94,]  124  125
##  [95,]  125  126
##  [96,]  126  127
##  [97,]  127   14
##  [98,]  127  128
##  [99,]  128  129
## [100,]  129   15
## [101,]  124  130
## [102,]  130   16
## [103,]  123  131
## [104,]  131   17
## [105,]  122  132
## [106,]  132  133
## [107,]  133  134
## [108,]  134  135
## [109,]  135   18
## [110,]  120  136
## [111,]  136  137
## [112,]  137  138
```

```
## [113,]   138   139
## [114,]   139   140
## [115,]   140   141
## [116,]   141    19
## [117,]   139   142
## [118,]   142   143
## [119,]   143    20
## [120,]   138   144
## [121,]   144    21
## [122,]    54   145
## [123,]   145   146
## [124,]   146   147
## [125,]   147   148
## [126,]   148   149
## [127,]   149   150
## [128,]   150   151
## [129,]   151   152
## [130,]   152   153
## [131,]   153   154
## [132,]   154   155
## [133,]   155   156
## [134,]   156   157
## [135,]   157   158
## [136,]   158   159
## [137,]   159   160
## [138,]   160   161
## [139,]   161   162
## [140,]   162    22
## [141,]   161   163
## [142,]   163    23
## [143,]   154   164
## [144,]   164   165
## [145,]   165   166
## [146,]   166   167
## [147,]   167    24
## [148,]    52   168
## [149,]   168   169
## [150,]   169   170
## [151,]   170    25
## [152,]    44   171
## [153,]   171   172
## [154,]   172   173
## [155,]   173   174
## [156,]   174   175
## [157,]   175   176
## [158,]   176   177
## [159,]   177   178
## [160,]   178   179
## [161,]   179   180
## [162,]   180   181
## [163,]   181   182
## [164,]   182   183
## [165,]   183   184
## [166,]   184   185
```

```
## [167,]   185   186
## [168,]   186   187
## [169,]   187   188
## [170,]   188   189
## [171,]   189   190
## [172,]   190   191
## [173,]   191   192
## [174,]   192   193
## [175,]   193   194
## [176,]   194   195
## [177,]   195   196
## [178,]   196   197
## [179,]   197   198
## [180,]   198   199
## [181,]   199   200
## [182,]   200   201
## [183,]   201   202
## [184,]   202   203
## [185,]   203   204
## [186,]   204   205
## [187,]   205   206
## [188,]   206   207
## [189,]   207   208
## [190,]   208   209
## [191,]   209   210
## [192,]   210   211
## [193,]   211   212
## [194,]   212   213
## [195,]   213   214
## [196,]   214   215
## [197,]   215   216
## [198,]   216   217
## [199,]   217   218
## [200,]   218   219
## [201,]   219   220
## [202,]   220   221
## [203,]   221   222
## [204,]   222   223
## [205,]   223   224
## [206,]   224   225
## [207,]   225   226
## [208,]   226   227
## [209,]   227   228
## [210,]   228   229
## [211,]   229   230
## [212,]   230   231
## [213,]   231   232
## [214,]   232    26
## [215,]   222   233
## [216,]   233   234
## [217,]   234   235
## [218,]   235   236
## [219,]   236   237
## [220,]   237   238
```

```
## [221,]   238   239
## [222,]   239   240
## [223,]   240   241
## [224,]   241   242
## [225,]   242   243
## [226,]   243   244
## [227,]   244   245
## [228,]   245   246
## [229,]   246   247
## [230,]   247   248
## [231,]   248   249
## [232,]   249    27
## [233,]   246   250
## [234,]   250   251
## [235,]   251   252
## [236,]   252   253
## [237,]   253   254
## [238,]   254   255
## [239,]   255   256
## [240,]   256   257
## [241,]   257   258
## [242,]   258   259
## [243,]   259    28
## [244,]   254   260
## [245,]   260   261
## [246,]   261    29
## [247,]   253   262
## [248,]   262   263
## [249,]   263   264
## [250,]   264   265
## [251,]   265   266
## [252,]   266    30
## [253,]   252   267
## [254,]   267   268
## [255,]   268   269
## [256,]   269   270
## [257,]   270   271
## [258,]   271    31
## [259,]   250   272
## [260,]   272   273
## [261,]   273   274
## [262,]   274   275
## [263,]   275   276
## [264,]   276   277
## [265,]   277   278
## [266,]   278    32
## [267,]   272   279
## [268,]   279   280
## [269,]   280   281
## [270,]   281    33
## [271,]   279   282
## [272,]   282   283
## [273,]   283    34
## [274,]   202   284
```

```
## [275,]   284   285
## [276,]   285   286
## [277,]   286   287
## [278,]   287   288
## [279,]   288   289
## [280,]   289   290
## [281,]   290   291
## [282,]   291   292
## [283,]   292   293
## [284,]   293   294
## [285,]   294   295
## [286,]   295    35
## [287,]   200   296
## [288,]   296   297
## [289,]   297   298
## [290,]   298   299
## [291,]   299   300
## [292,]   300   301
## [293,]   301   302
## [294,]   302   303
## [295,]   303   304
## [296,]   304   305
## [297,]   305   306
## [298,]   306   307
## [299,]   307   308
## [300,]   308   309
## [301,]   309   310
## [302,]   310   311
## [303,]   311    36
## [304,]   178   312
## [305,]   312   313
## [306,]   313   314
## [307,]   314   315
## [308,]   315   316
## [309,]   316   317
## [310,]   317   318
## [311,]   318   319
## [312,]   319   320
## [313,]   320   321
## [314,]   321   322
## [315,]   322   323
## [316,]   323   324
## [317,]   324   325
## [318,]   325   326
## [319,]   326   327
## [320,]   327   328
## [321,]   328   329
## [322,]   329   330
## [323,]   330   331
## [324,]   331   332
## [325,]   332   333
## [326,]   333   334
## [327,]   334   335
## [328,]   335   336
```

```
## [329,]  336  337
## [330,]  337  338
## [331,]  338  339
## [332,]  339  340
## [333,]  340  341
## [334,]  341  342
## [335,]  342  343
## [336,]  343  344
## [337,]  344   37
## [338,]  343   38
## [339,]  318  345
## [340,]  345  346
## [341,]  346  347
## [342,]  347  348
## [343,]  348  349
## [344,]  349  350
## [345,]  350  351
## [346,]  351  352
## [347,]  352  353
## [348,]  353  354
## [349,]  354  355
## [350,]  355  356
## [351,]  356  357
## [352,]  357  358
## [353,]  358  359
## [354,]  359  360
## [355,]  360  361
## [356,]  361  362
## [357,]  362  363
## [358,]  363  364
## [359,]  364  365
## [360,]  365  366
## [361,]  366  367
## [362,]  367  368
## [363,]  368  369
## [364,]  369  370
## [365,]  370  371
## [366,]  371  372
## [367,]  372  373
## [368,]  373  374
## [369,]  374   39
## [370,]  368   40
## [371,]  351  375
## [372,]  375  376
## [373,]  376   41
## [374,]  317  377
## [375,]  377  378
## [376,]  378  379
## [377,]  379  380
## [378,]  380  381
## [379,]  381  382
## [380,]  382  383
## [381,]  383  384
## [382,]  384  385
```

```
## [383,]  385  386
## [384,]  386   42
## [385,]  386  387
## [386,]  387  388
## [387,]  388   43
```

plotting phylogenetic trees

```
plot.phylo(x = portal_tree)
```
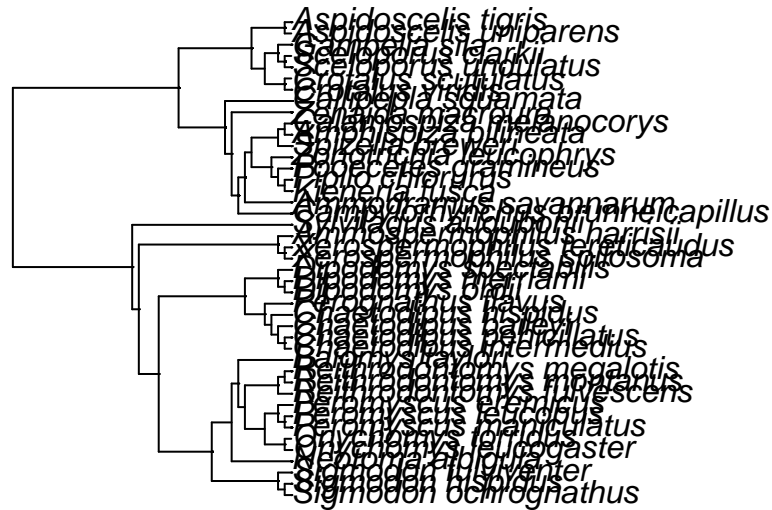

an extension of phylogenetic visualization: ggtree to install packages from bioconductor we need a CRAN package called biocmanager

```
install.packages("BiocManager")
install("ggtree")
```

```
library(BiocManager)
library(ggtree)
```

```
## ggtree v3.4.4 For help: https://yulab-smu.top/treedata-book/
##
## If you use the ggtree package suite in published research, please cite
## the appropriate paper(s):
```

```
## 
## Guangchuang Yu, David Smith, Huachen Zhu, Yi Guan, Tommy Tsan-Yuk Lam.
## ggtree: an R package for visualization and annotation of phylogenetic
## trees with their covariates and other associated data. Methods in
## Ecology and Evolution. 2017, 8(1):28-36. doi:10.1111/2041-210X.12628
## 
## S Xu, Z Dai, P Guo, X Fu, S Liu, L Zhou, W Tang, T Feng, M Chen, L
## Zhan, T Wu, E Hu, Y Jiang, X Bo, G Yu. ggtreeExtra: Compact
## visualization of richly annotated phylogenetic data. Molecular Biology
## and Evolution. 2021, 38(9):4039-4042. doi: 10.1093/molbev/msab166
## 
## Guangchuang Yu, Tommy Tsan-Yuk Lam, Huachen Zhu, Yi Guan. Two methods
## for mapping and visualizing associated data on phylogeny using ggtree.
## Molecular Biology and Evolution. 2018, 35(12):3041-3043.
## doi:10.1093/molbev/msy194
```

```
## 
## Attaching package: 'ggtree'
```

```
## The following object is masked from 'package:ape':
## 
##     rotate
```

```
ggtree(portal_tree)
```
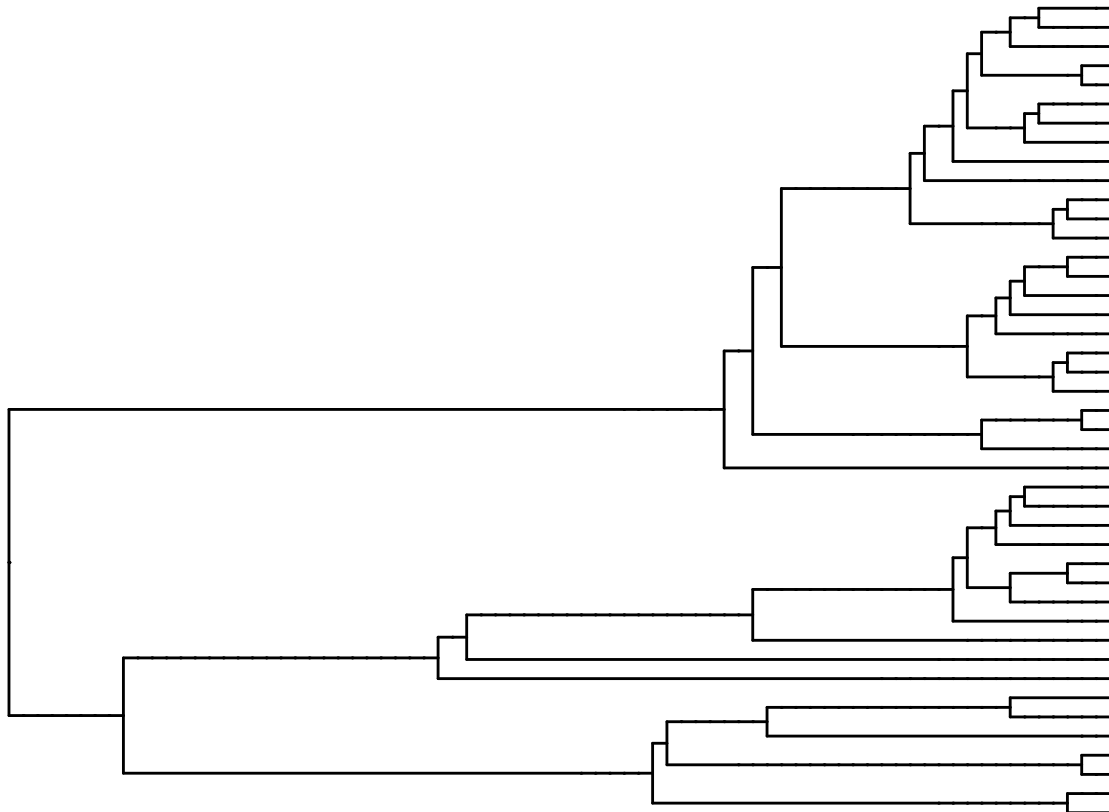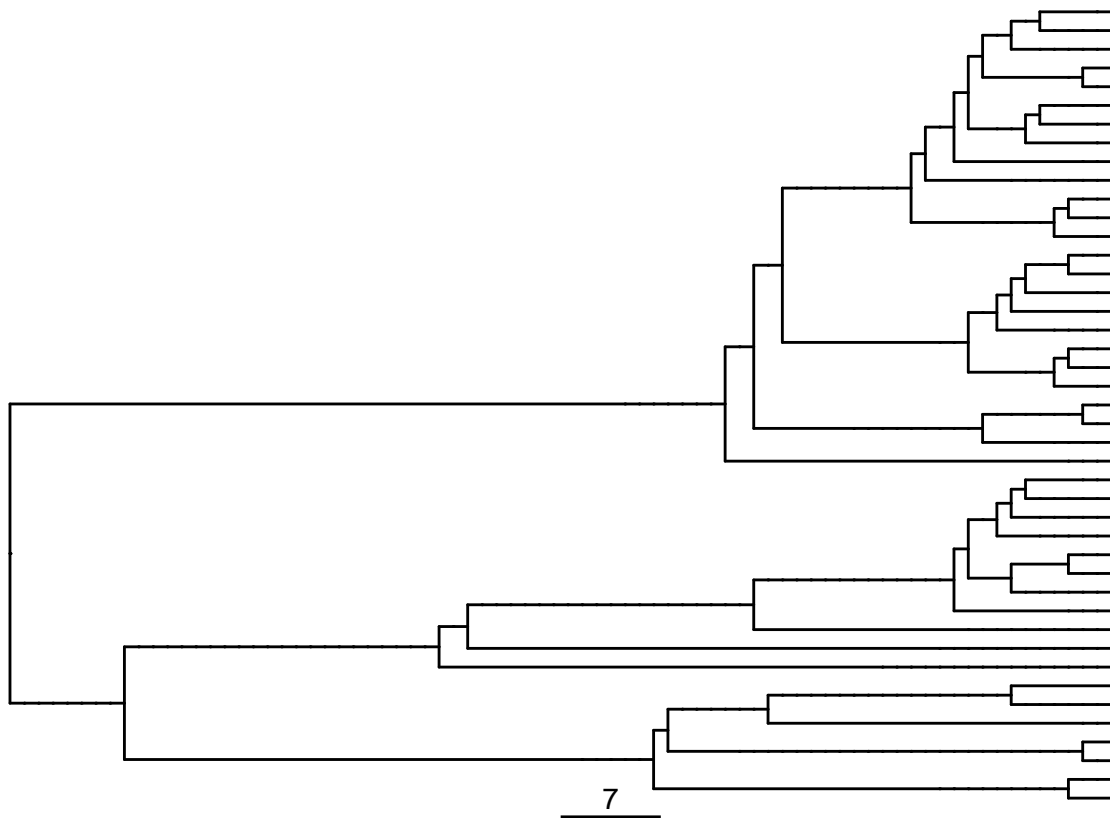


```
# this is equivalent to:
```

```
ggplot(portal_tree, aes(x, y)) +
  geom_tree() +
  theme_tree()
```
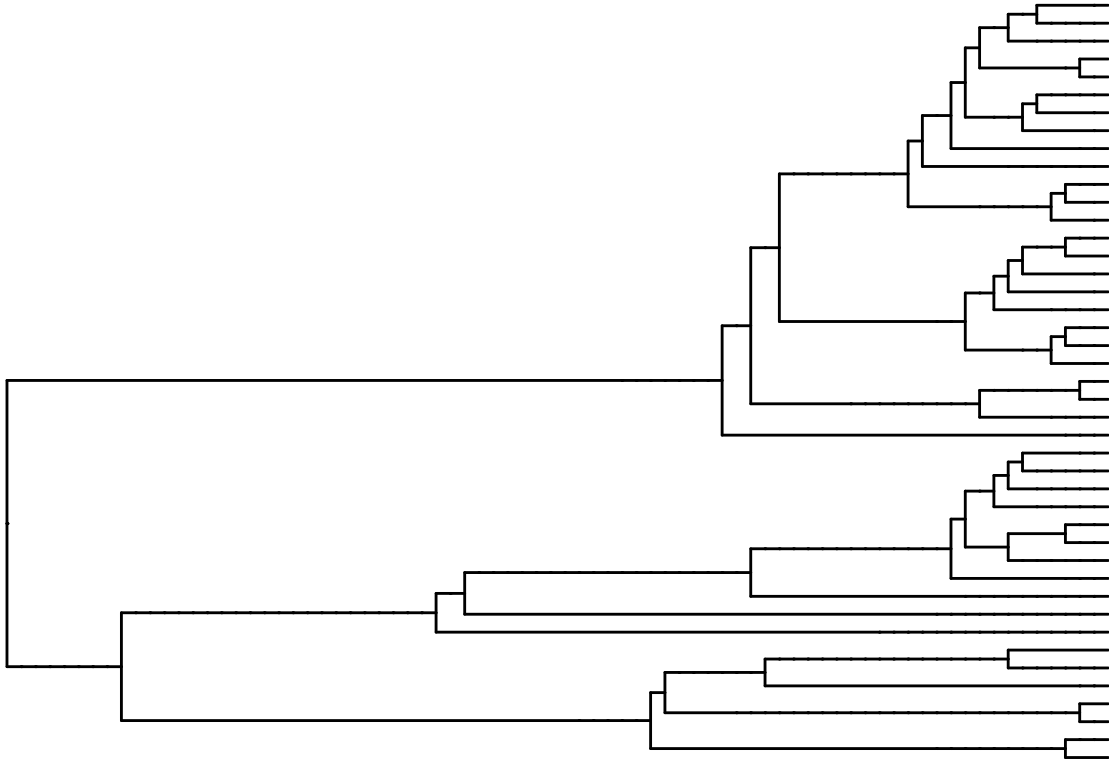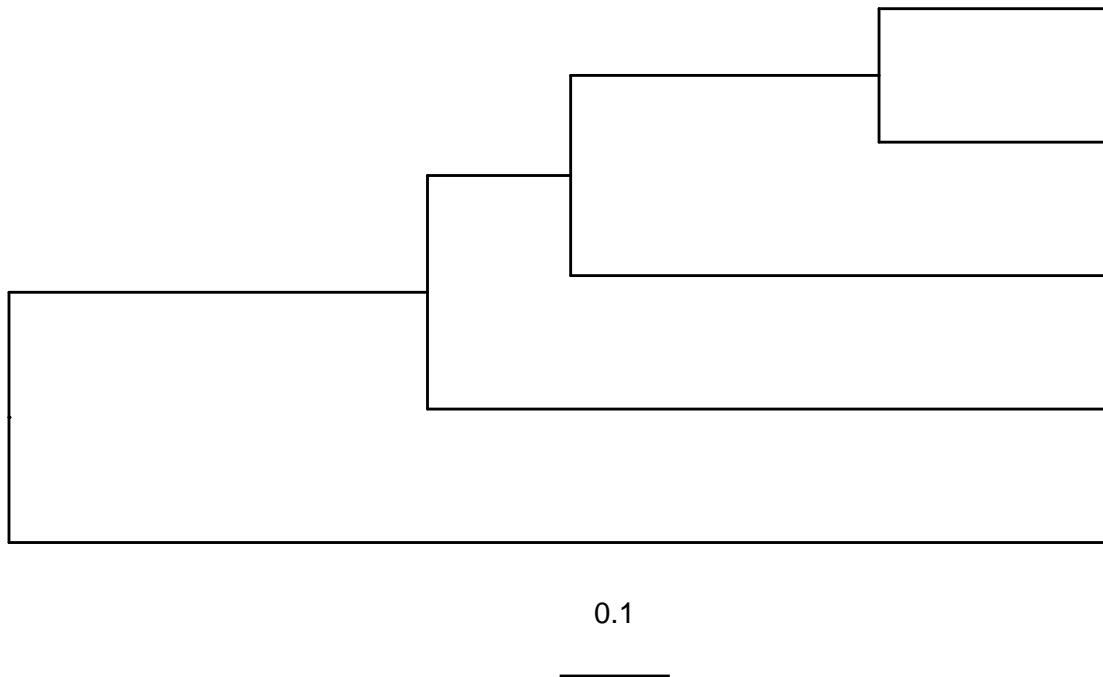

add a scale with the function geom_treescale()

```
ggtree(portal_tree) +
  geom_treescale()
```

exercise: plot the small tree of five species of primates and include a scale what is the difference in structure between the two trees?

```
ggtree(small_tree) +
  geom_treescale()
```

0.1

- A difference in number of tips (43 vs 5) - our small_tree does not have node.label as opposed to the portal trees but it does include branch lengths through the edge.length element as shown by the tree above

```
names(small_tree)
```

```
## [1] "edge"        "edge.length" "Nnode"        "tip.label"
```

```
summary(small_tree)
```

```
##
## Phylogenetic tree: small_tree
##
##    Number of tips: 5
##    Number of nodes: 4
##    Branch lengths:
##      mean: 0.415
##      variance: 0.08208571
##      distribution summary:
##    Min. 1st Qu.  Median 3rd Qu.    Max.
##  0.1300  0.2100  0.3300  0.5225  1.0000
##    No root edge.
##    Tip labels: Homo
##               Pongo
##               Macaca
##               Ateles
##               Galago
```

```
##   No node labels.
```

```
str(small_tree)
```

```
## List of 4
##  $ edge       : int [1:8, 1:2] 6 7 8 9 9 8 7 6 7 8 ...
##  $ edge.length: num [1:8] 0.38 0.13 0.28 0.21 0.21 0.49 0.62 1
##  $ Nnode      : int 4
##  $ tip.label  : chr [1:5] "Homo" "Pongo" "Macaca" "Ateles" ...
##  - attr(*, "class")= chr "phylo"
##  - attr(*, "order")= chr "cladewise"
```

```
class(small_tree$edge.length)
```
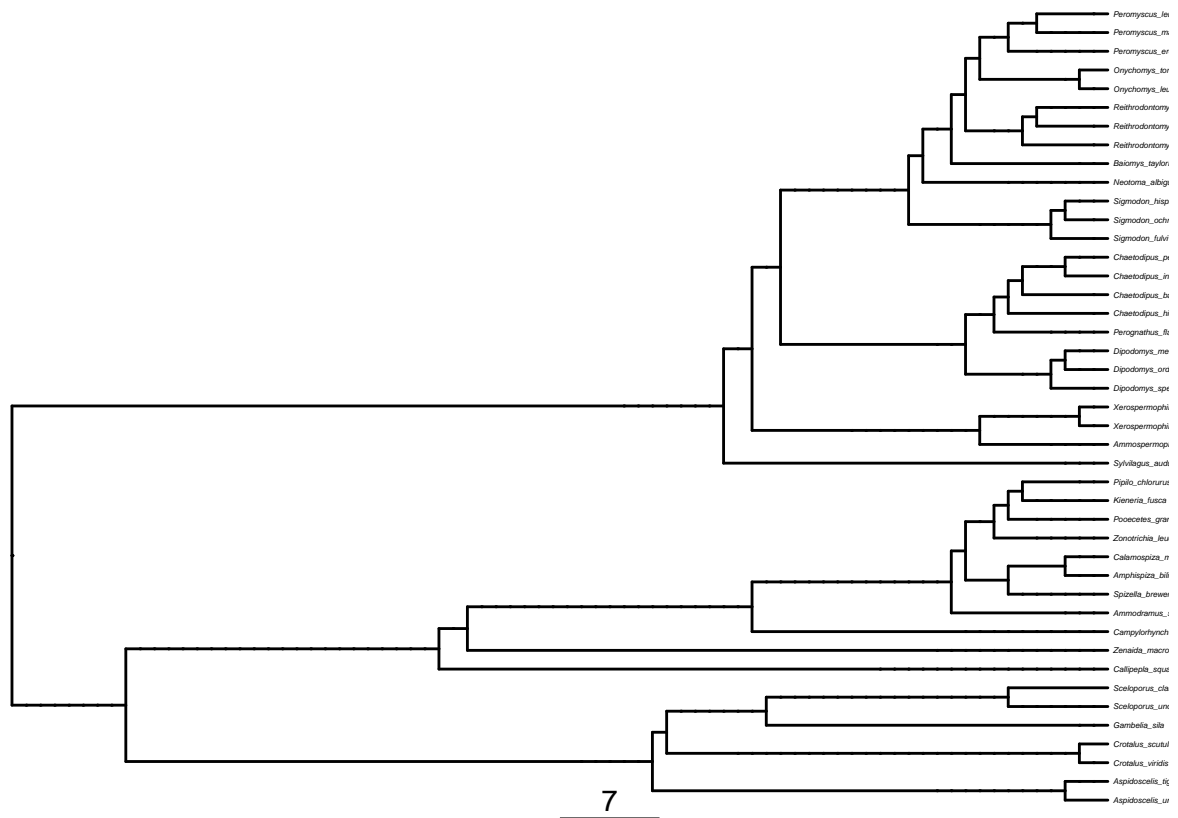
```
## [1] "numeric"
```

```
small_tree$edge.length
```

```
## [1] 0.38 0.13 0.28 0.21 0.21 0.49 0.62 1.00
```

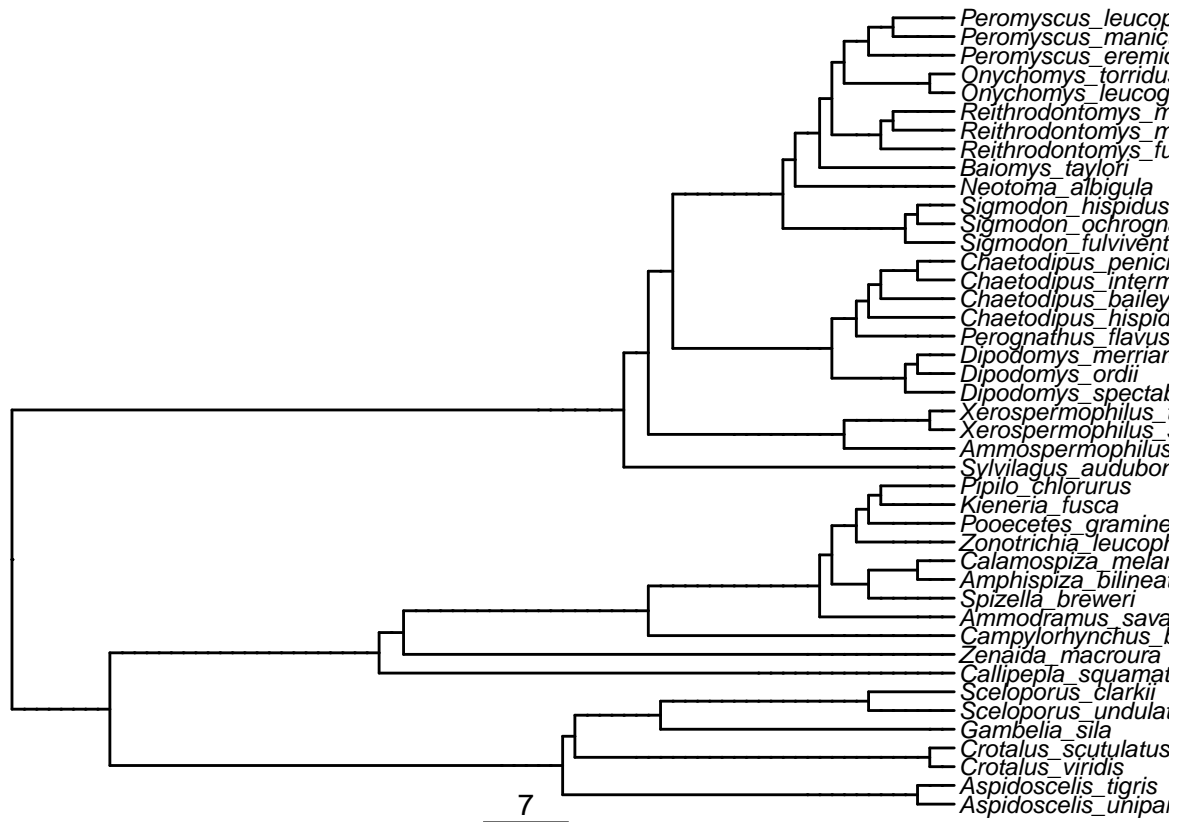## add tip labels and node labels

Because a plot is nothing without labels

```
ggtree(portal_tree) +
  geom_treescale() +
  geom_tiplab(size = 1, col = "cyan", fontface = "italic")
```

add a limit to the plot so we can see the labels

```
ggtree(portal_tree) +
  geom_treescale() +
  geom_tiplab(size = 3, col = "springgreen", fontface = "italic") +
  xlim(NA, 90)
```

```
#age of each node
branching.times(small_tree)
```

```
##    6    7    8    9
## 1.00 0.62 0.49 0.21
```

homework: make a plot for small_tree with scale, tip labels, and an appropriate, and an approprate xlim size to display names fully