

附录

分析中生代鸟类数据的 MrBayes 命令, 包括注释。更多结果和讨论参见先前的研究 (Zhang and Wang 2019)。MrBayes 3.2.8 版本可以从最新的源代码编译 (<https://github.com/NBISweden/MrBayes>)。

Begin MrBayes;

[read in data matrix]

execute birds.nex;

[substitution model]

ctype ordered: 1 3 8 28 31 43 51 56 64 67 69 70 72 74 92 107 117 159 168 176 183
193 205 213 214 216 219 222 229 233 234 249 261 265 268 270;

lset coding = variable rates = gamma; [Mkv+Gamma model]

[tip dates]

calibrate

Dromaeosauridae = uniform(66.0, 167.7)

Archaeopteryx = uniform(145.0, 152.1)

Jeholornis = uniform(110.6, 125.0)

Chongmingia = uniform(110.6, 120.3)

Sapeornis = uniform(110.6, 125.0)

Confuciusornis_sanctus = uniform(110.6, 125.0)

Changchengornis = uniform(120.3, 125.0)

Eoconfuciusornis = uniform(129.0, 130.7)

Confuciusornis_dui = uniform(120.3, 125.0)

Yangavis = uniform(120.3, 125.0)

Boluochia = uniform(110.6, 120.0)

Concornis = uniform(120.3, 125.0)

Elsornis = uniform(70.6, 84.9)

Eoalulavis = uniform(120.3, 125.0)

Cathayornis = uniform(110.6, 120.3)

Eocathayornis = uniform(110.6, 120.3)

Eoenantiornis = uniform(120.3, 125.0)

Gobipteryx = uniform(72.1, 83.6)

Longipteryx = uniform(110.6, 120.3)

Longirostravis = uniform(120.3, 125.0)

Neuquenornis = uniform(79.5, 83.5)

Pengornis = uniform(110.6, 120.3)

Eopengornis = uniform(129.0, 130.7)

Protopteryx = uniform(129.0, 130.7)

Rapaxavis = uniform(110.6, 120.3)

Shanweiniiao = uniform(120.3, 125.0)
 Vescornis = uniform(121.6, 122.5)
 Qiliania = uniform(112.6, 125.4)
 Dunhuangia = uniform(112.6, 125.4)
 Piscivorenantiornis = uniform(110.6, 120.3)
 Linyiornis = uniform(110.6, 120.3)
 Sulcavis = uniform(110.6, 120.3)
 Bohaiornis = uniform(110.6, 120.3)
 Longusunguis = uniform(110.6, 120.3)
 Shenqiornis = uniform(121.6, 122.5)
 Zhouornis = uniform(110.6, 120.3)
 Parabohaiornis = uniform(110.6, 120.3)
 Fortunguavis = uniform(110.6, 120.3)
 Pterygornis = uniform(110.6, 120.3)
 Cruralispennia = uniform(129.0, 130.7)
 Monoenantiornis = uniform(120.3, 125.0)
 Archaeorhynchus = uniform(110.6, 125.0)
 Schizothura = uniform(110.6, 120.3)
 Bellulornis = uniform(110.6, 120.3)
 Vorona = uniform(66.0, 72.1)
 Jianchangornis = uniform(110.6, 120.3)
 Songlingornis = uniform(110.6, 120.3)
 Longicrusavis = uniform(120.3, 125.0)
 Apsaravis = uniform(72.1, 83.6)
 Hongshanornis = uniform(120.3, 125.0)
 Archaeornithura = uniform(129.0, 130.7)
 Parahongshanornis = uniform(110.6, 120.3)
 Tianyuornis = uniform(120.3, 125.0)
 Yanornis = uniform(110.6, 120.3)
 Patagopteryx = uniform(79.5, 83.5)
 Yixianornis = uniform(120.3, 125.0)
 Piscivoravis = uniform(110.6, 120.3)
 Iteravis = uniform(110.6, 120.3)
 Gansus = uniform(113.0, 120.3)
 Ichthyornis = uniform(70.6, 94.3)
 Hesperornis = uniform(66.0, 84.9)
 Parahesperornis = uniform(70.6, 84.9)
 Enaliornis = uniform(100.5, 113.0)
 Baptornis_advenus = uniform(85.8, 89.3)
 Baptornis_varneri = uniform(70.6, 84.9)
 Vegavis = uniform(66.0, 68.0)

;

prset nodeagepr = calibrated;

```
[fossilized birth-death model]
prset brlenspr = clock:fossilization;
[diversified extant sampling, followed by 3 fossil sampling rate shifts]
[and 1 speciation rate shift at 66 Ma, extinction rate is assumed constant]
prset samplestrat = diversity 3: 145 100 66, 1: 66;
prset sampleprob = 0.0002; [two out of about 10000 extant species]
prset speciationpr = exp(100); [net diversification rate, d]
prset extinctionpr = beta(4, 1); [turnover rate, v]
prset fossilizationpr = beta(1, 9); [relative fossil-sampling rate, s]
prset treeagepr = offsetexp(153, 169); [root age]

[relaxed clock model]
prset clockratepr = gamma(2, 100); [base clock rate]
prset clockvarpr = iln; [independent lognormal relaxed clock]

[topology constraints]
constraint Aves = 2-.; [ingroup]
constraint Pygostylia = 4-.;
constraint Ornithothoraces = 11-68;
constraint Enantiornithines = 11-41;
constraint Ornithuromorpha = 42-68;
prset topologypr = constraint(Aves, Pygostylia, Enantiornithines,
Ornithuromorpha);

[MCMC settings]
mcmcp nrun = 2 nchain = 4 ngen = 50000000 samplefr = 2000 printfr = 50000
diagnfr = 500000;
mcmc filename = birds;

[summarize tree and parameters, default burnin fraction 0.25]
sumt;
sump;
End;
```