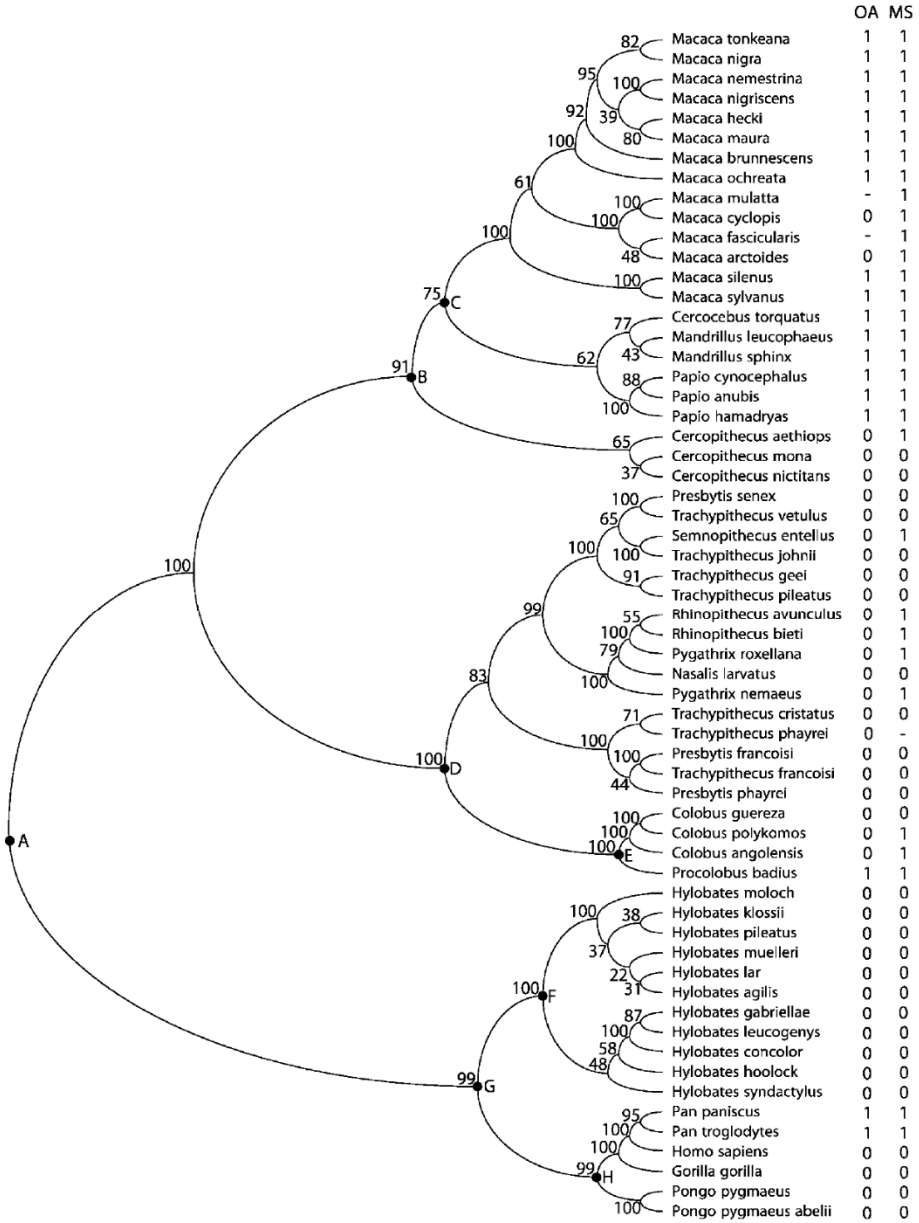
Analysis of dependent evolution by BayesTraits and Beast

Evolution of estrus advertisement and multimale system

Bayesian analysis of correlated evolution of discrete characters by reversible-jump Markov chain Monte Carlo



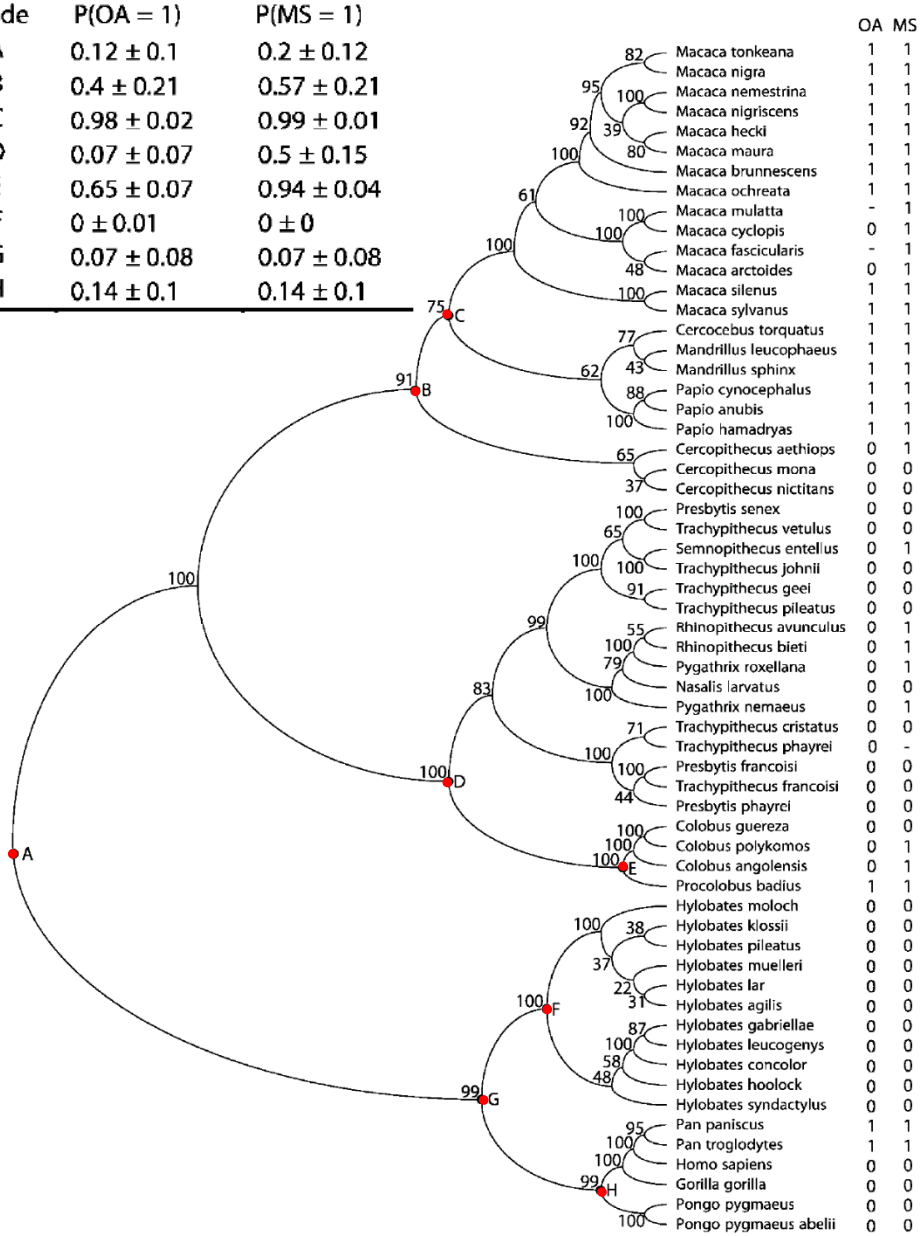
OA: estrus advertisement

MS: multimale system

Pagel and Meade. (2006) the American Naturalist **167:** 808–825

Ancestral states of the phenotypic traits

Node	P(OA = 1)	P(MS = 1)
A	0.12 ± 0.1	0.2 ± 0.12
B	0.4 ± 0.21	0.57 ± 0.21
C	0.98 ± 0.02	0.99 ± 0.01
D	0.07 ± 0.07	0.5 ± 0.15
E	0.65 ± 0.07	0.94 ± 0.04
F	0 ± 0.01	0 ± 0
G	0.07 ± 0.08	0.07 ± 0.08
H	0.14 ± 0.1	0.14 ± 0.1



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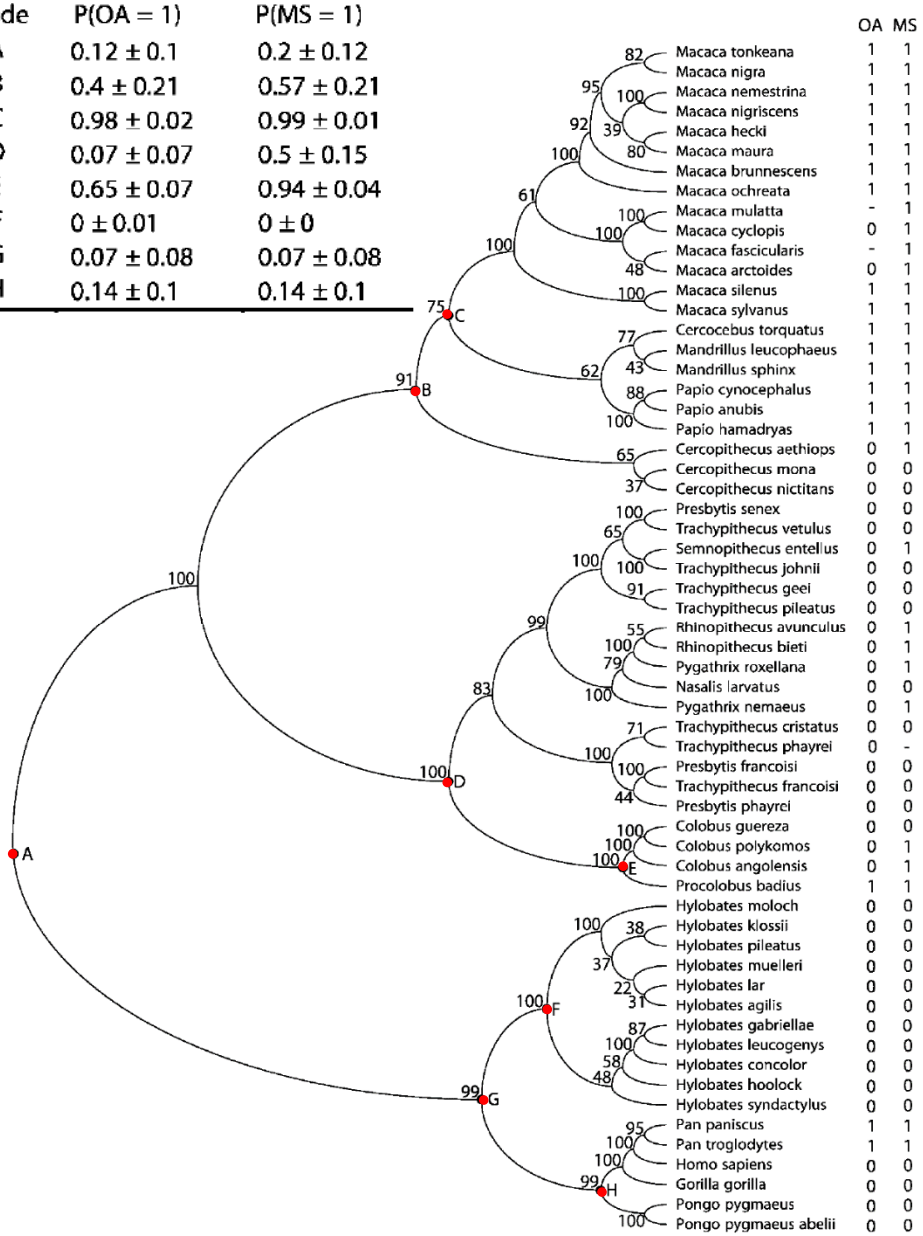

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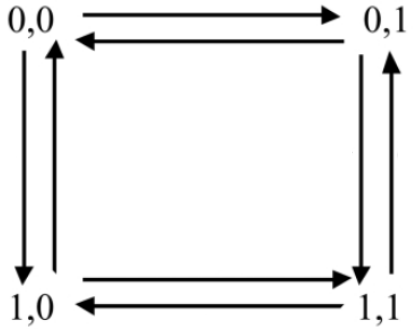

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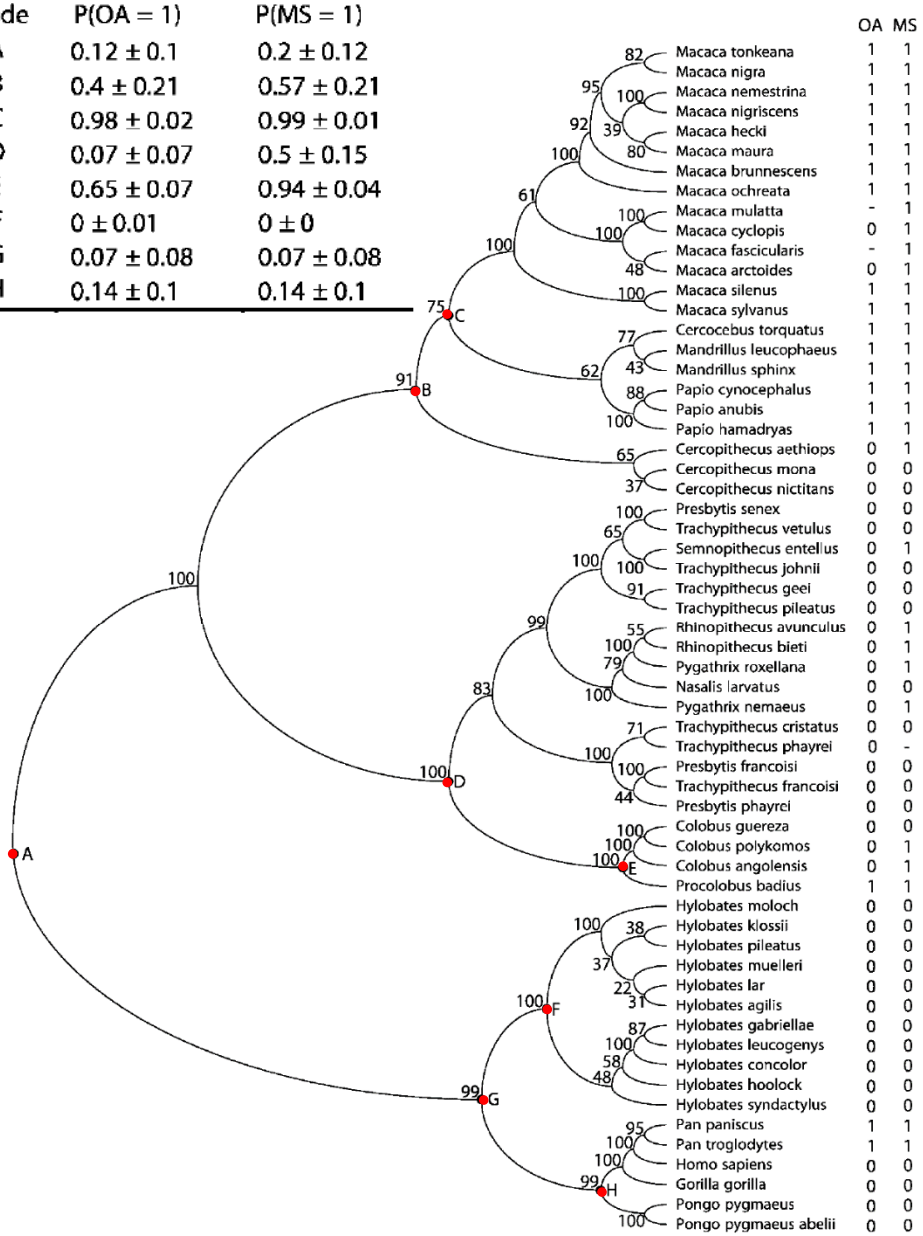

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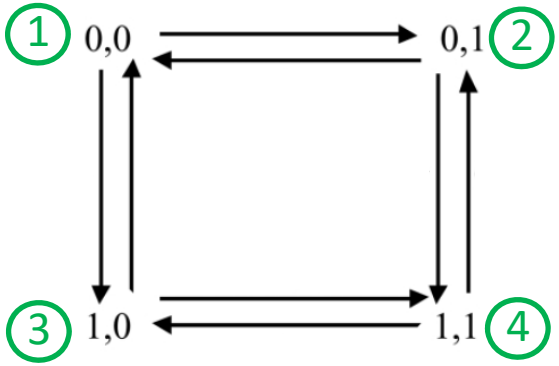

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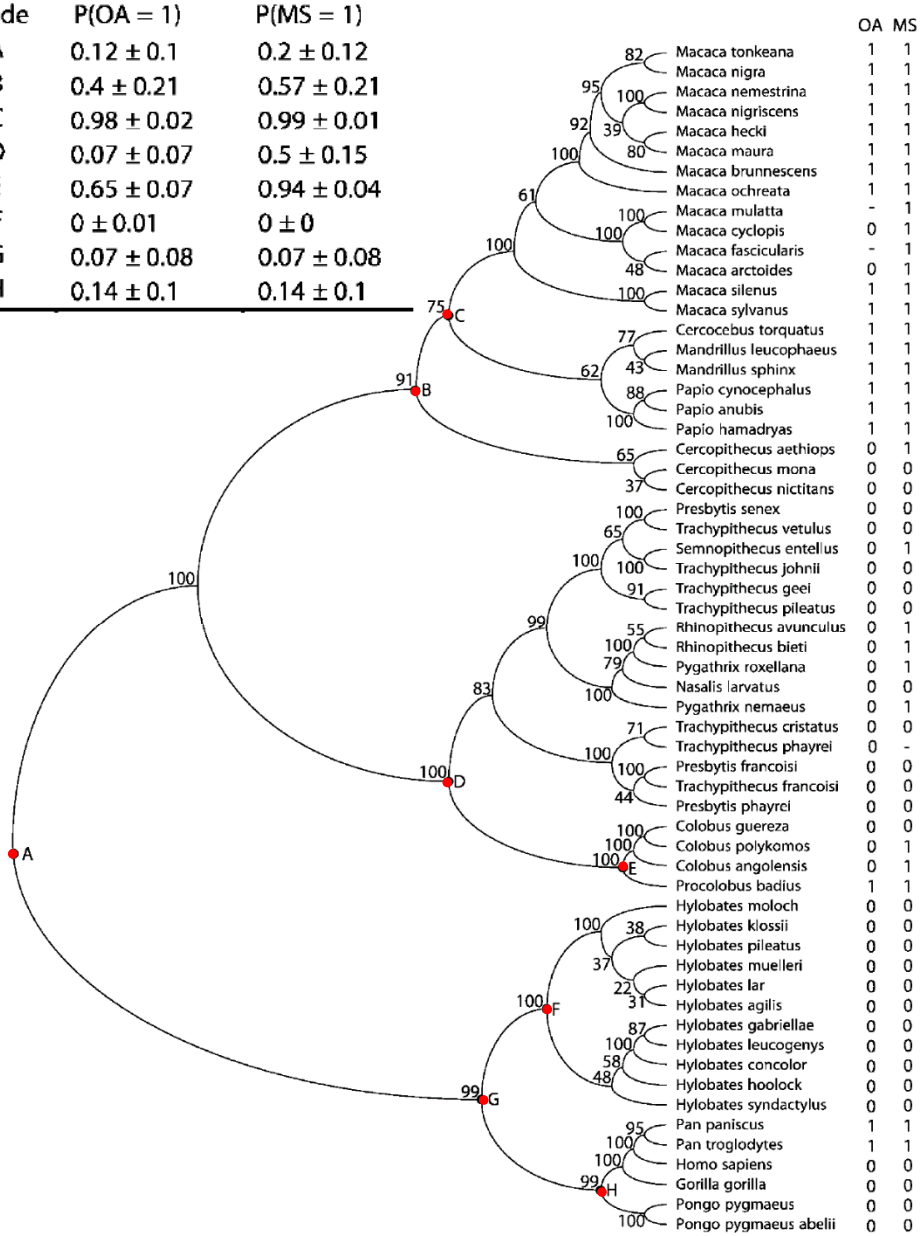

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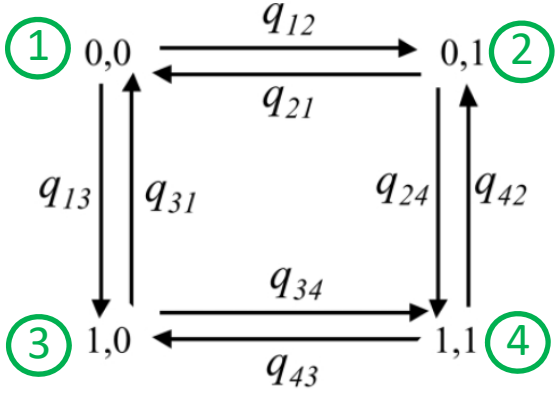

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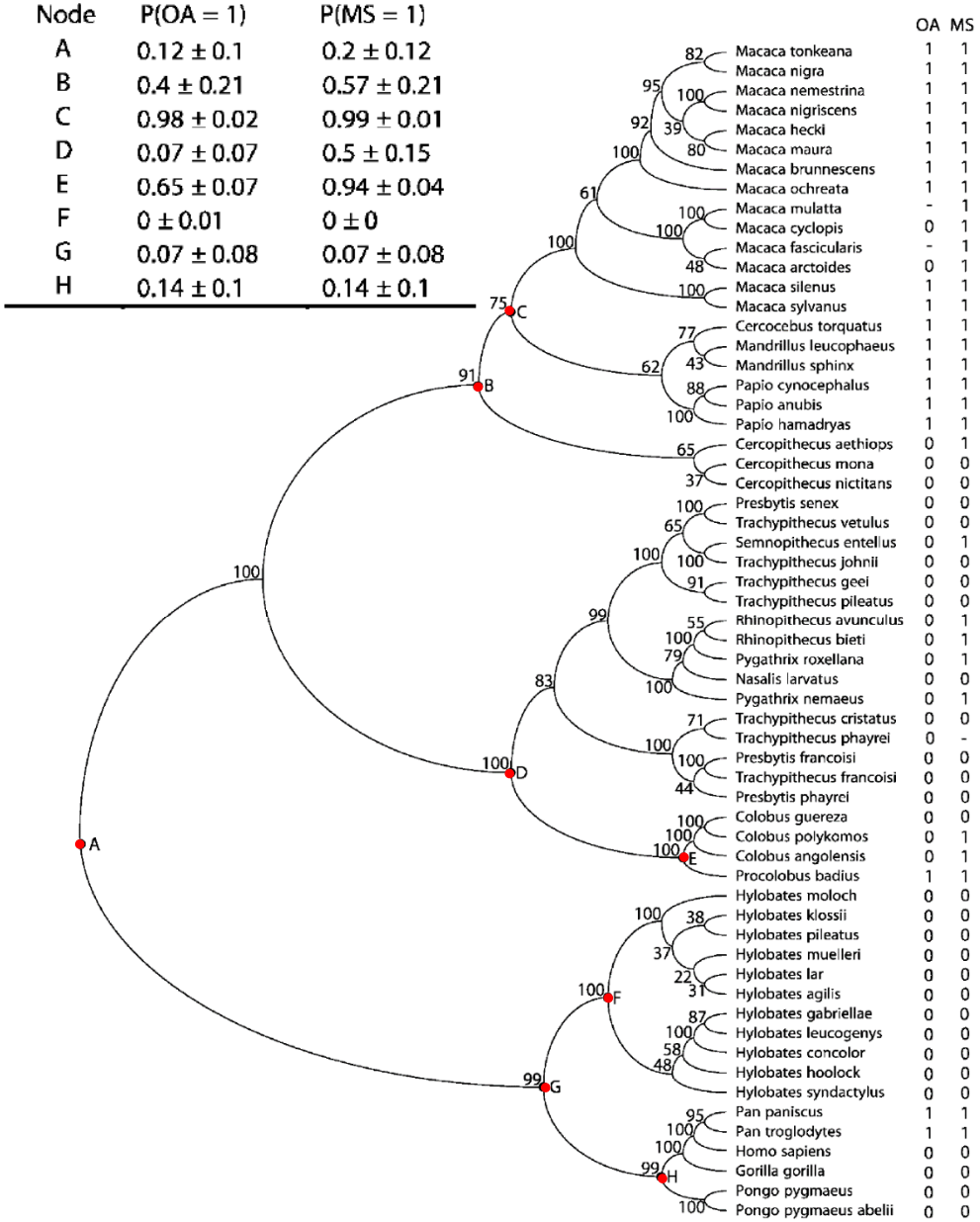

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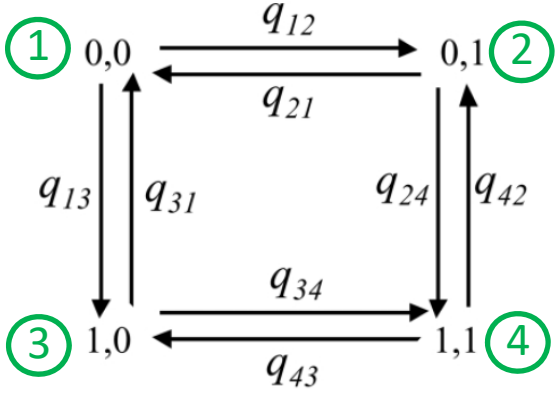

If OA and MS are independent,

$$q_{12} = q_{34}, q_{13} = q_{24}, q_{21} = q_{43}, q_{31} = q_{42}$$

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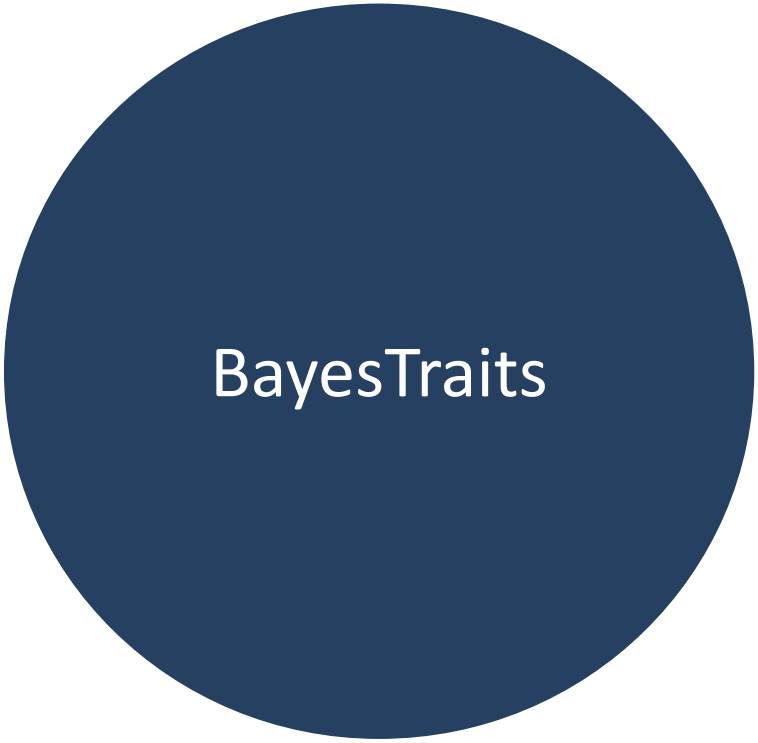
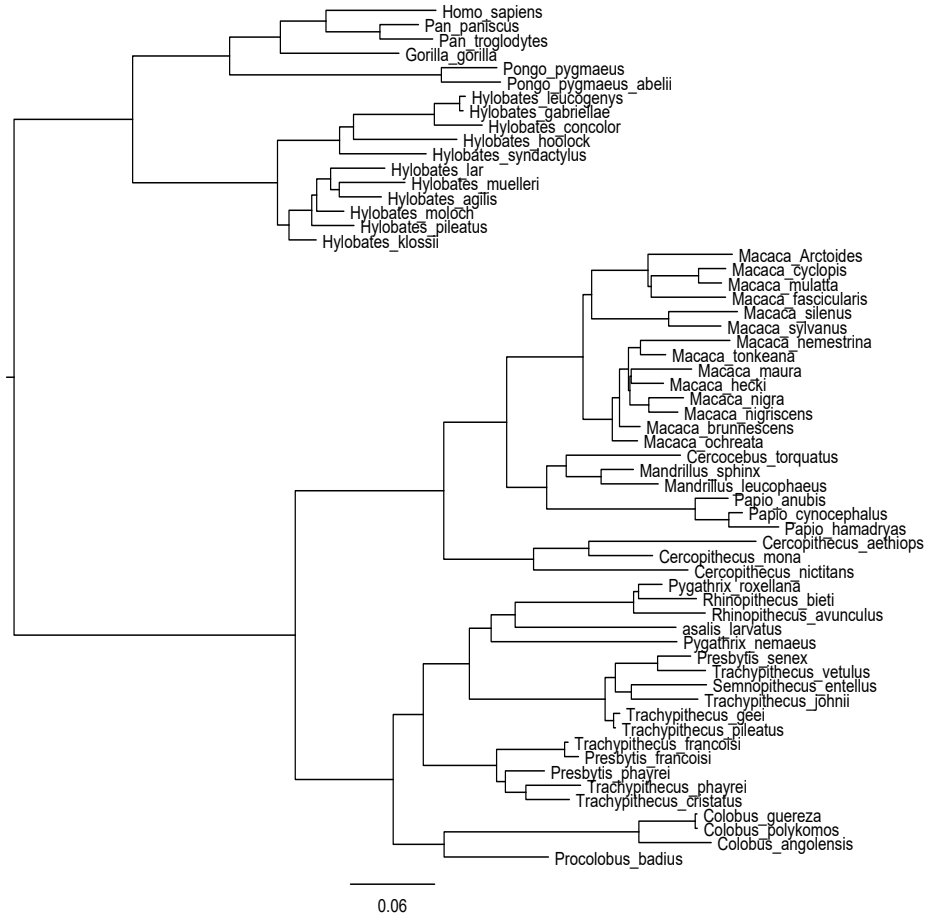

BayesTraits

Phenotype data

	OA (estrus advertisement)	MS (multimale system)
Cercocebus_torquatus	1	1
Cercopithecus_aethiops	0	1
Cercopithecus_mona	0	0
Cercopithecus_nictitans	0	0
Colobus_angolensis	0	1
. . .	. . .	. . .
Trachypithecus_johnii	0	0
Trachypithecus_phayrei	0	–
Trachypithecus_pileatus	0	0
Trachypithecus_vetulus	0	0
Macaca_Arctoides	0	1

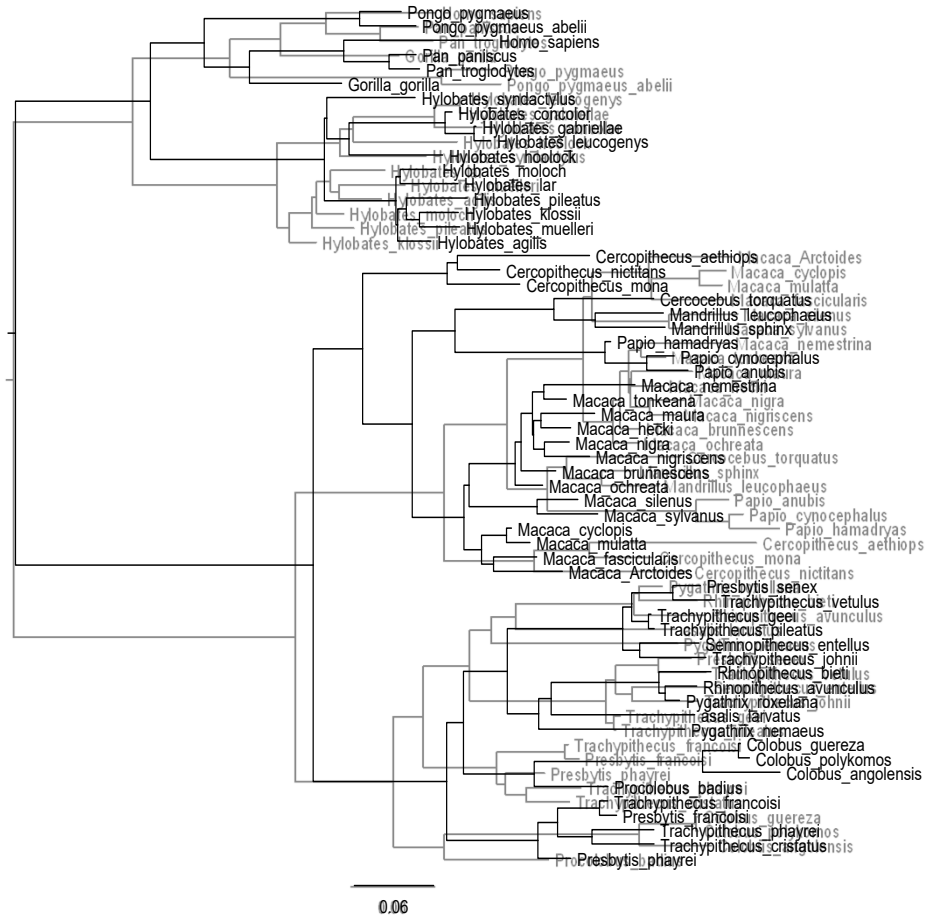
Primates.txt

Sample of phylogenetic trees



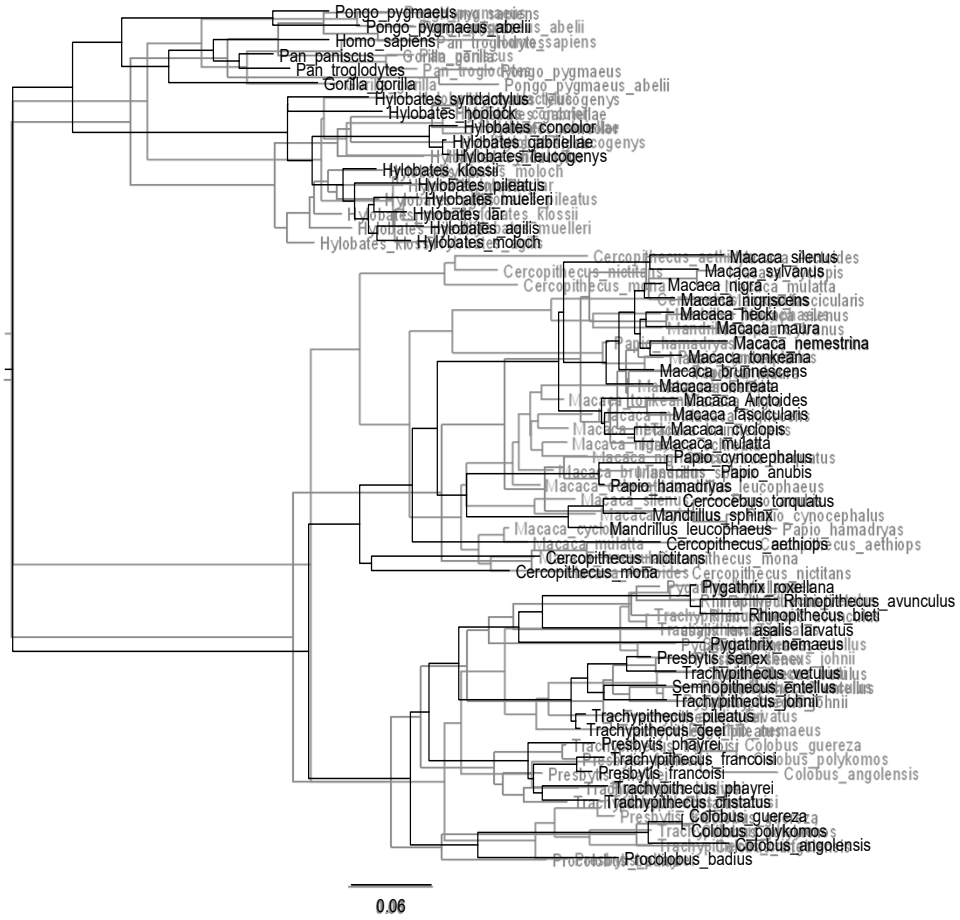
Primates.trees

Sample of phylogenetic trees



Primates.trees

Sample of phylogenetic trees



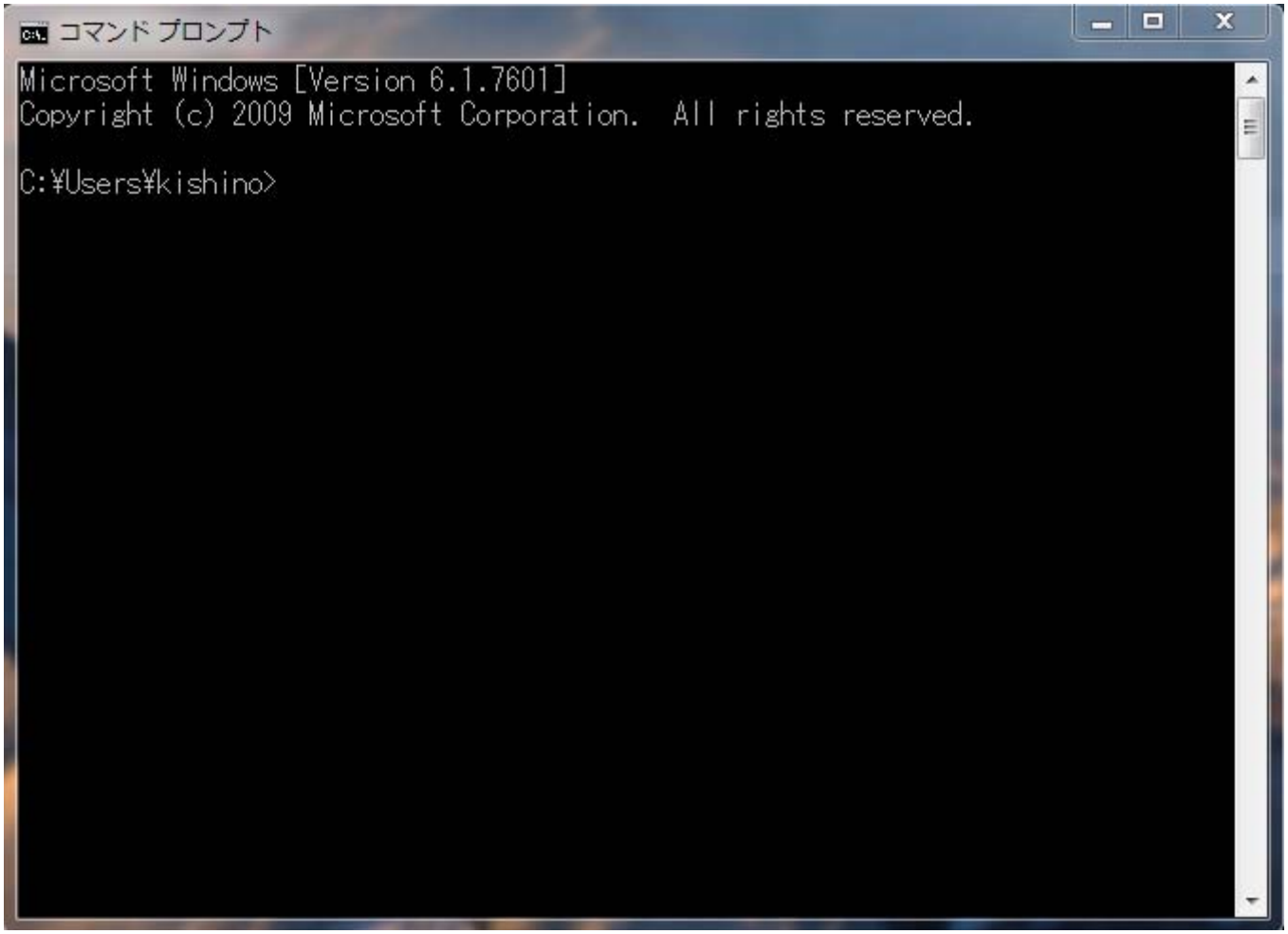
Primates.trees

Input data of nexus format (with numbered taxon labels)

```
#NEXUS
begin trees;
translate       0 Macaca_nigra,
                1 Macaca_nigriscens,
                2 Macaca_hecki,
                3 Macaca_maura,
                4 Macaca_brunnescens,
                5 Macaca_ochreata,
                6 Macaca_tonkeana,
                7 Macaca_nemestrina,
                    :
                    :
                59 Hylobates_hoolock,
                60 Hylobates_gabriellae,
                61 Hylobates_leucogenys,
                62 Hylobates_concolor,
                63 Hylobates_syndactylus;
                tree tree.1000000.15401.188591 =
(((((49:0.0782941654,(47:0.0274386027,48:0.0376982328):0.0383856984):0.0324635138,50:0.0844233208):0.0360892987,(51:0.039626940
2,52:0.0422367213):0.1507162725):0.0691150846,(((((61:0.0040714801,60:0.0025272896):0.0180012023,62:0.0341072891):0.0575818797,
59:0.0735752624):0.0099109761,63:0.0617128259):0.0442296997,((((53:0.0386429041,(54:0.0468533314,55:0.0299998724):0.0061189392)
:0.0098895008,58:0.0193324145):0.0035627704,57:0.0301218983):0.0161989756,56:0.0193803744):0.0082187543):0.1031336883):0.0844
409697,((((((11:0.0600272747,((14:0.0193420444,9:0.0164685671):0.0337746984,10:0.0530663992):0.0021923159):0.0401290303,(12:0.04
89192544,13:0.0372684364):0.0548789122):0.0061518378,((((7:0.0637067694,6:0.0179837688):0.0086445565,((3:0.0431478983,2:0.02306
66834):0.0009528807,(0:0.0247888526,1:0.0207365939):0.0134529226):0.0010402984):0.0062570267,4:0.0146612977):0.0051527227,5:0.
0179831656):0.0208712325):0.0543642548,((17:0.0813786359,(16:0.0230159969,15:0.0407400863):0.0247921981):0.0139680635,(20:0.02
34613934,(18:0.0097132601,19:0.0354868018):0.0239108755):0.1058350803):0.028440023):0.0447907576,((8:0.1191034123,41:0.0454711
039):0.0392934977,42:0.1099691306):0.0639193148):0.1058415618,(((((((25:0.0167686914,27:0.041362139):0.0034897968,26:0.05108202
49):0.0843071075,29:0.1145462956):0.0170944172,28:0.132258578):0.0154856425,(((30:0.0236261495,31:0.0342330943):0.0300760428,(3
4:0.0536502069,35:0.0474207936):0.01139838):0.0072423755,(32:0.0044772537,33:0.0013275067):0.0060003622):0.0966406977):0.03286
99046,((37:0.0025201324,36:0.0099154414):0.0484147288,(38:0.0277041325,(40:0.0390422756,39:0.0310514685):0.0144799485):0.00631
16373):0.0522287226):0.0213526038,(((21:0.0011864978,22:0.0014708895):0.0401009864,23:0.0514318435):0.1387109369,24:0.07426374
77):0.0362206142):0.0698634825):0.2001988551);
. . . . .
```

Primates.trees

Command prompt



Move by “cd” to the folder that includes the data and exec file

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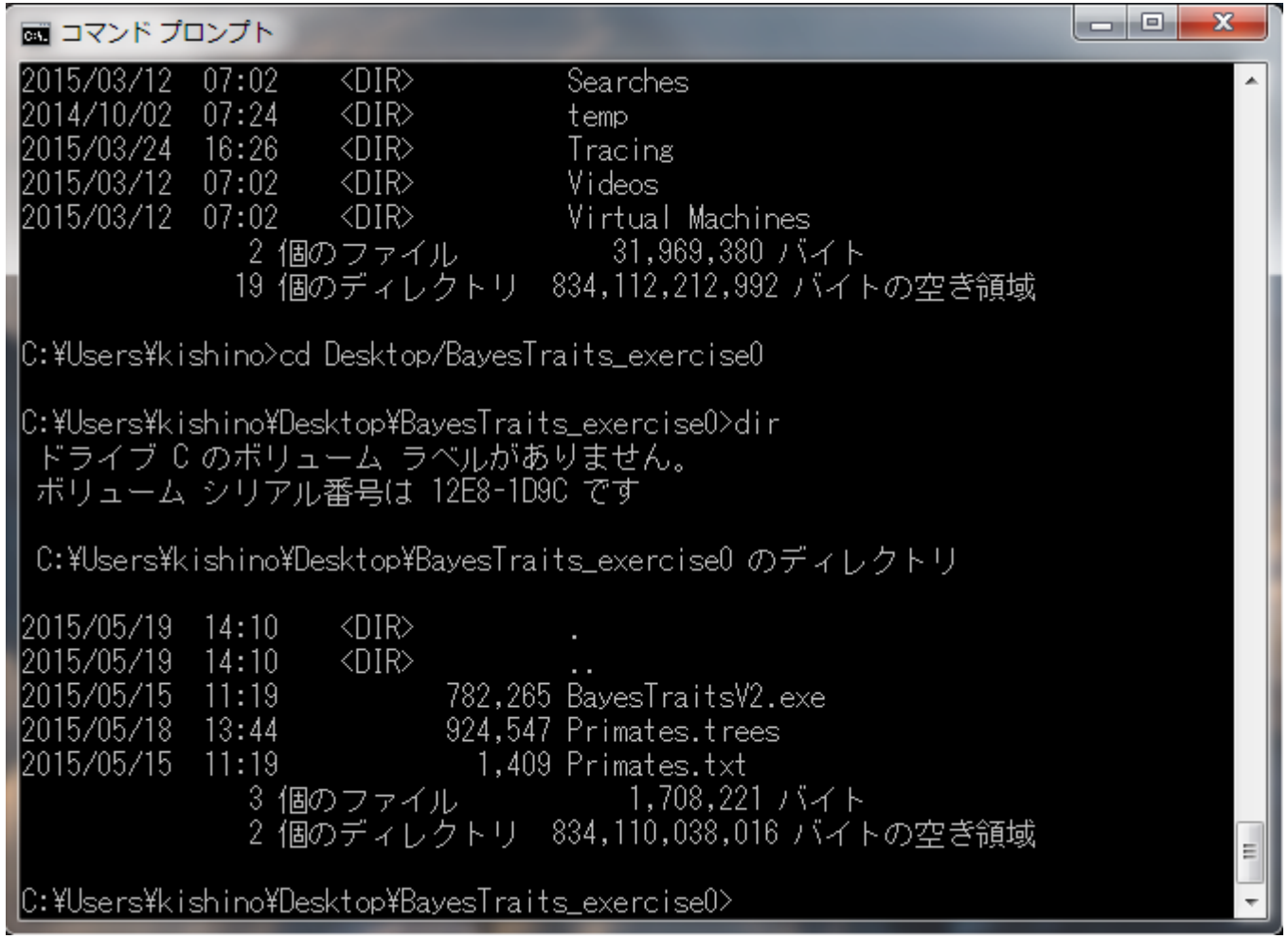
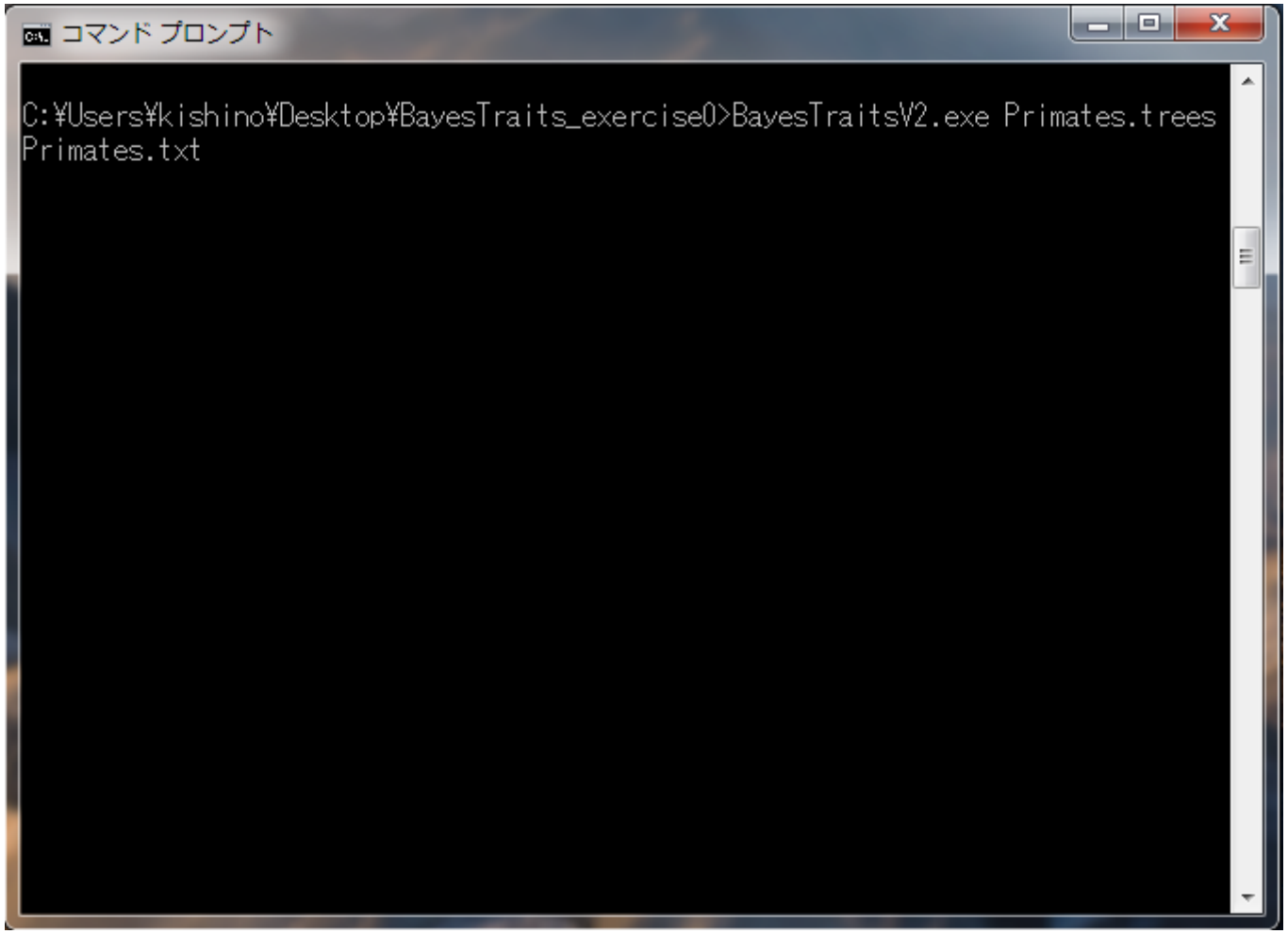
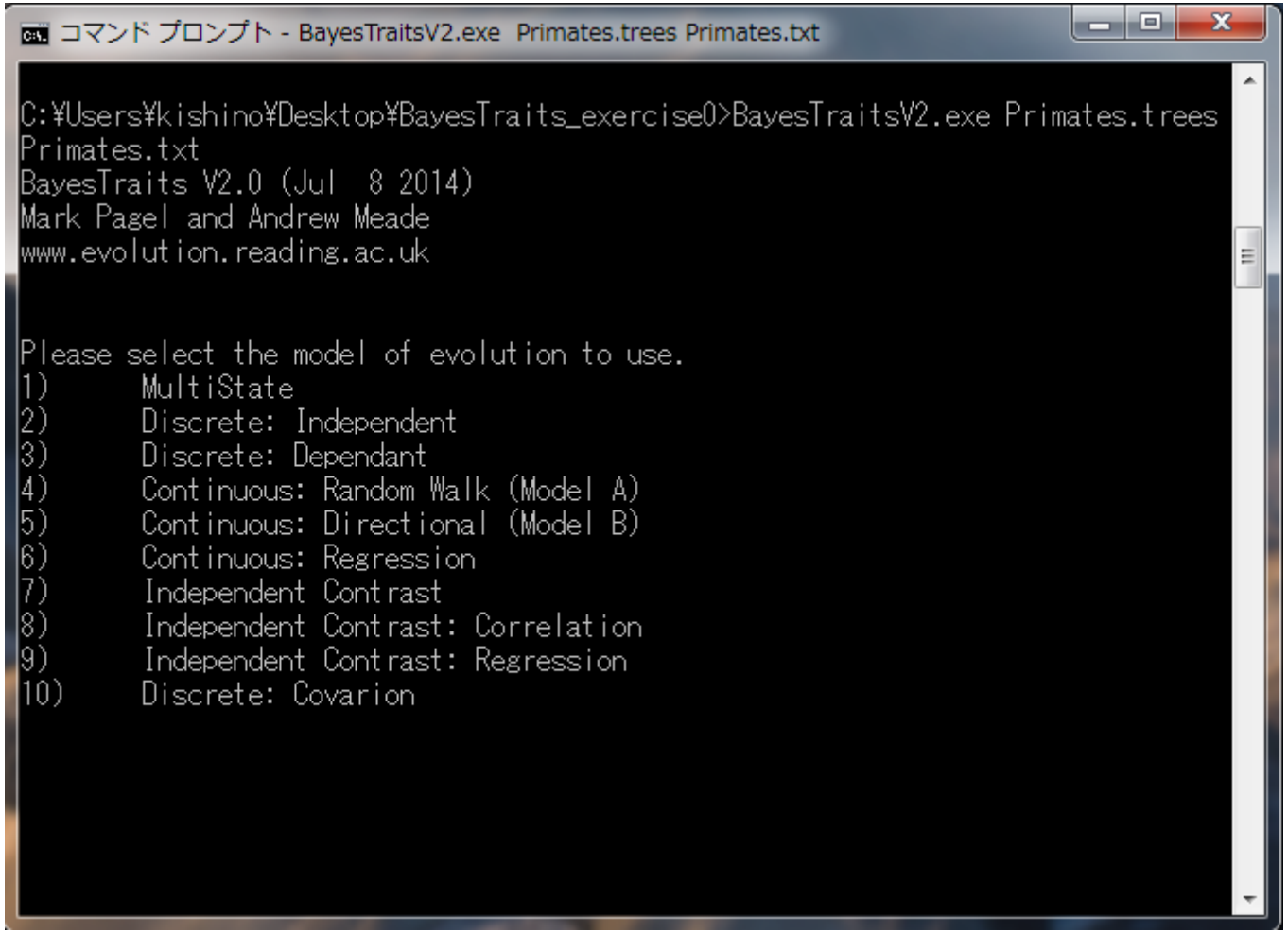


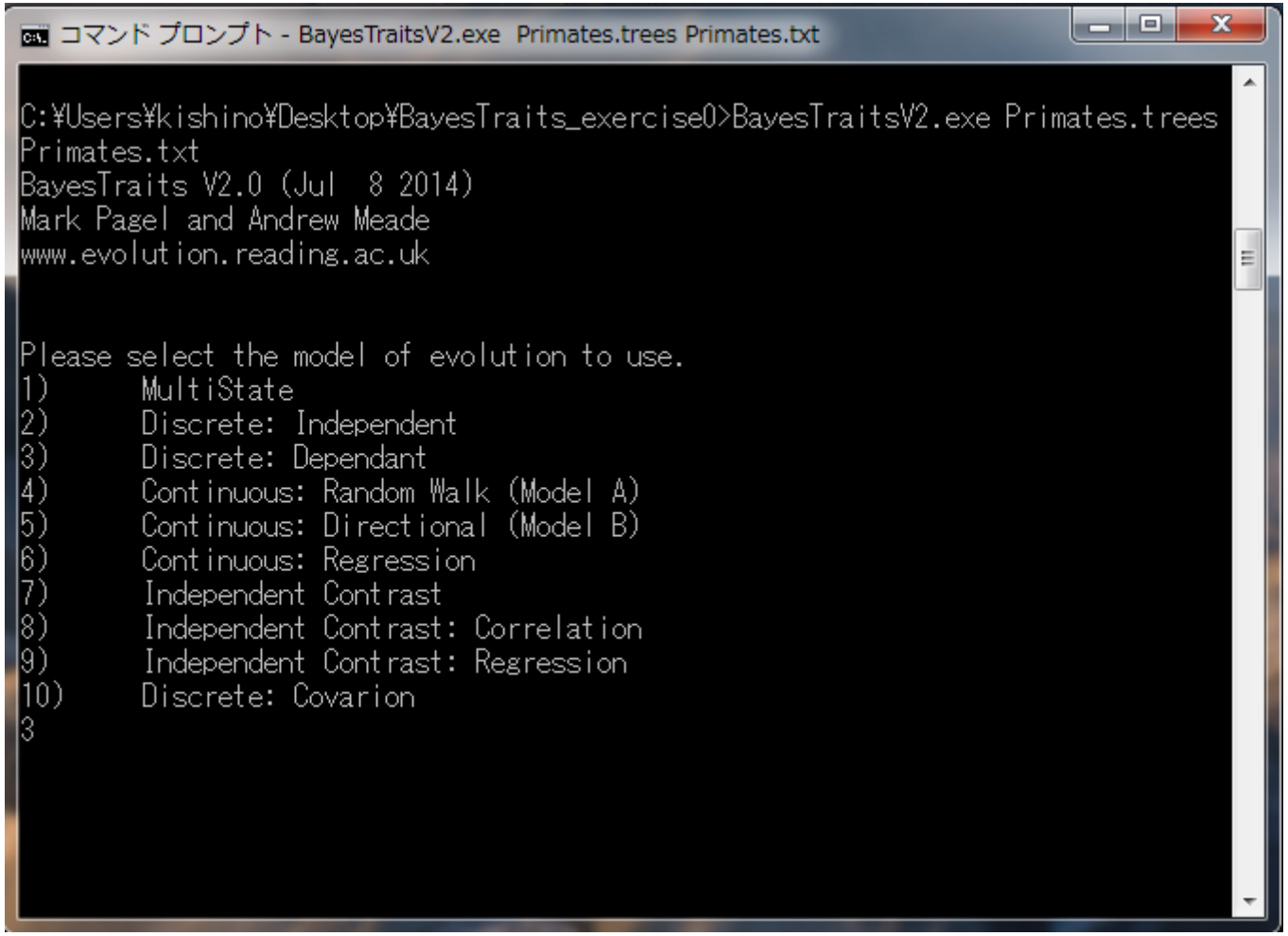
Run BayesTraitsV2.exe together with the two input files



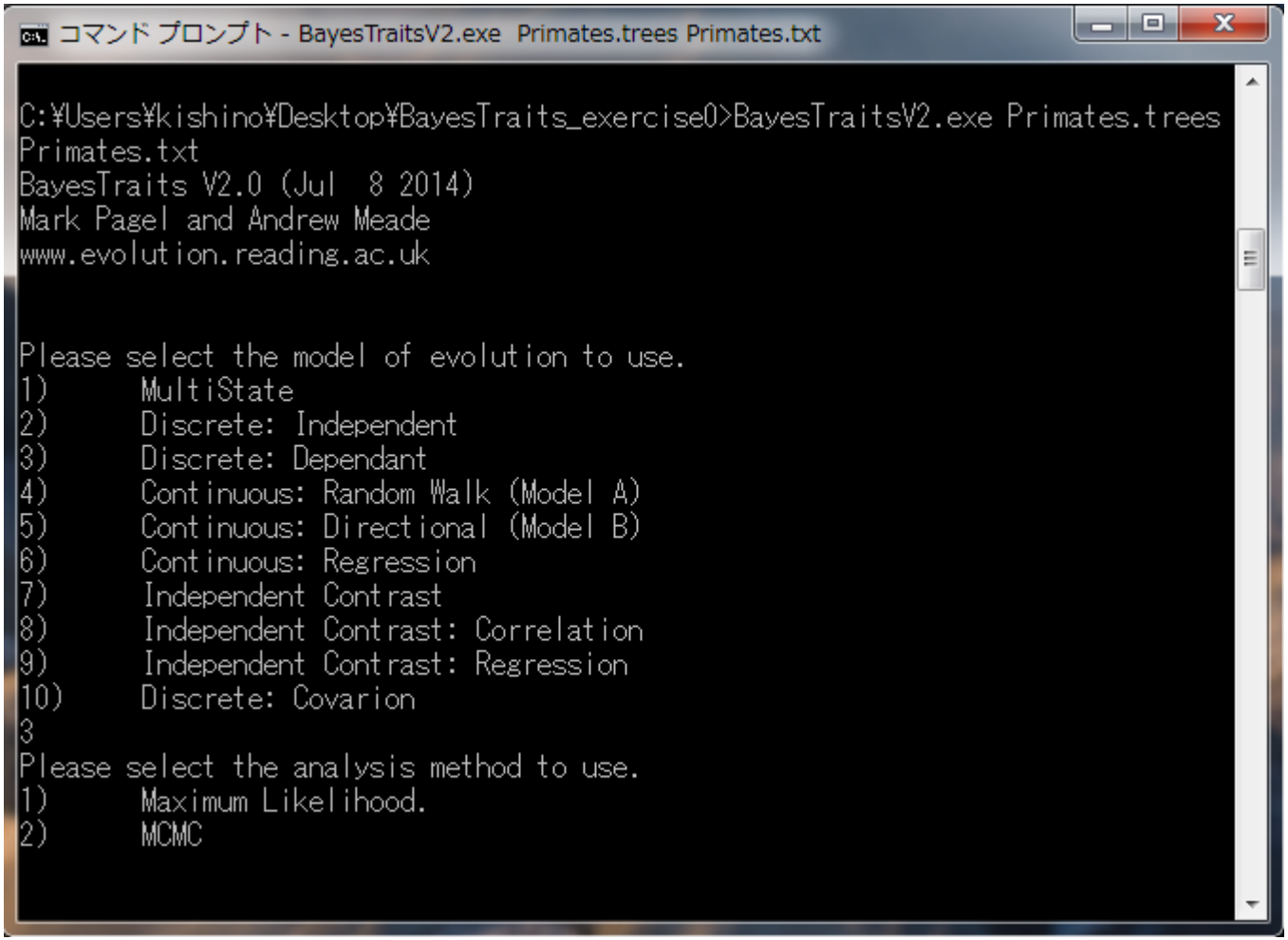
You will be asked to choose the model of evolution to use



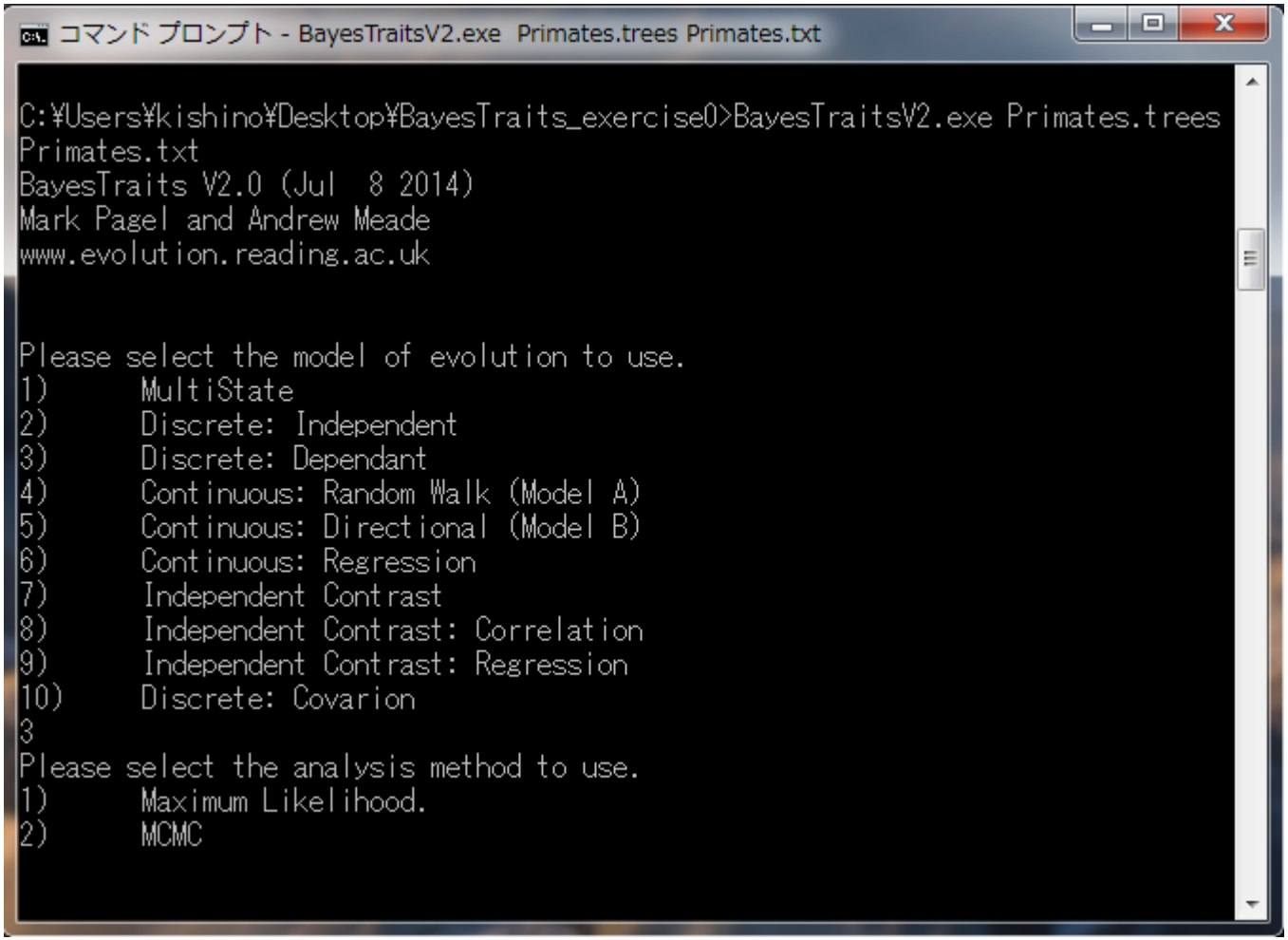
Select 3 (Discrete: Dependent)



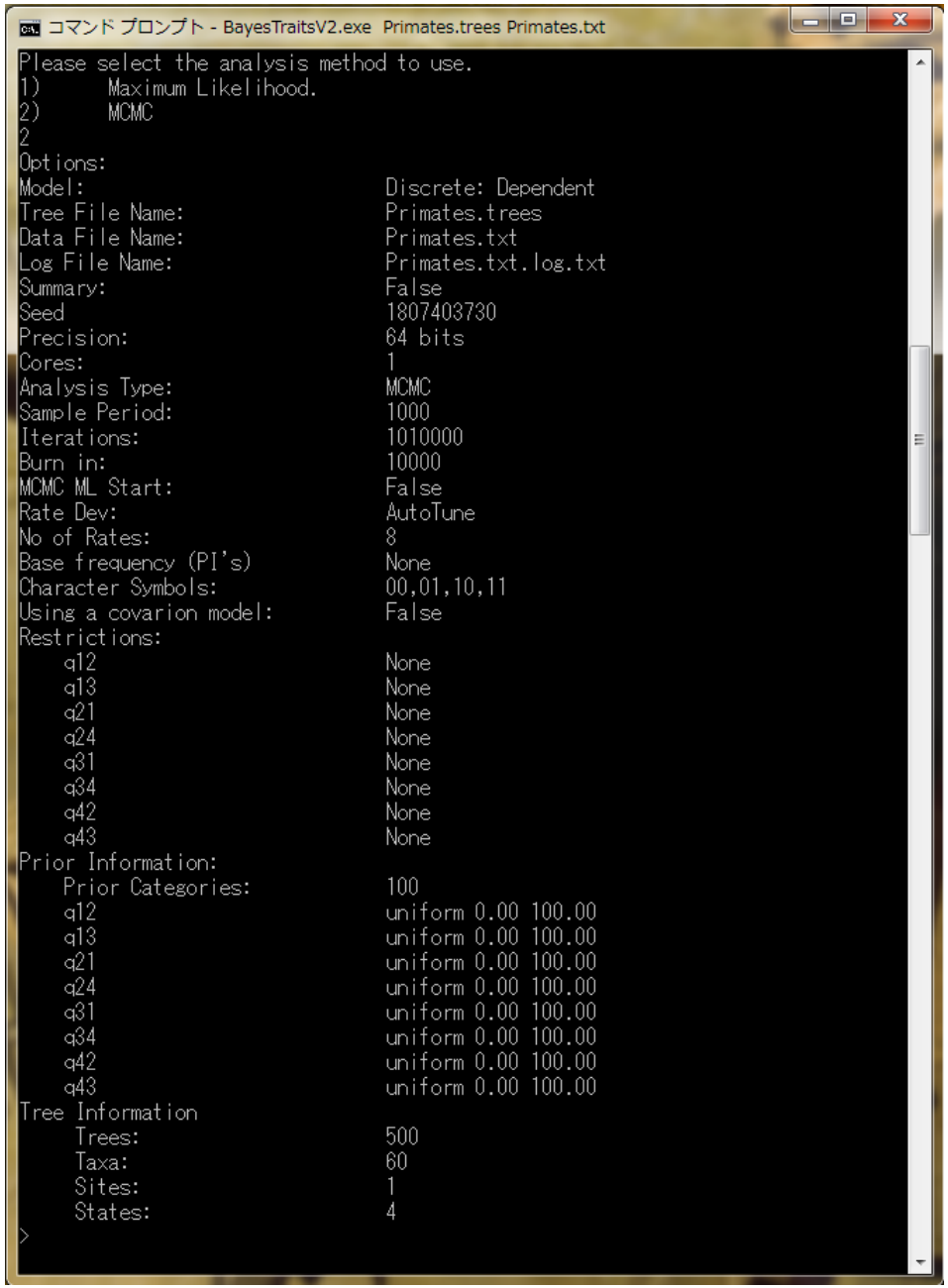
You will be asked to choose the analysis method (ML/Bayes)



Select 2 (Bayes: MCMC)



Confirm the selected model, priors, and input files etc



モデル：discrete, dependent
入力ファイル１：系統樹
入力ファイル２：形質値
出力ファイル

MCMCに関する情報
1000サイクルごとに保存
1010000サイクル実施
最初の10000回はburn-inとみなし、保存せず。

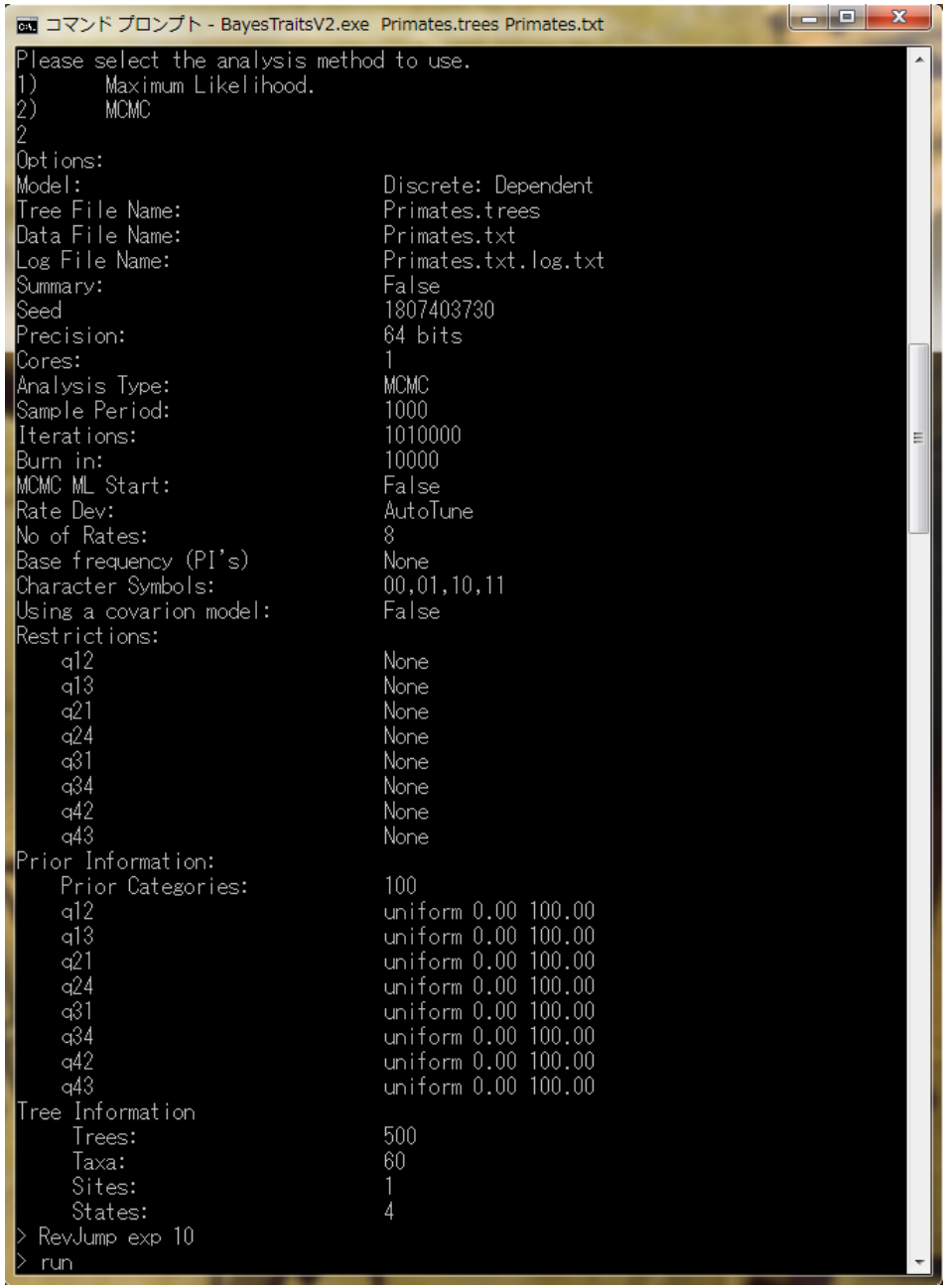
形質値のシンボル

制約条件
qij に制約条件なし

事前情報
qijの事前情報は0-100の一様分布

系統樹の情報

Run reversible jump MCMC with exp(rate=10) prior



Model: discrete, dependent
Input file 1: data of phylogenetic trees
Input file 2: data of the traits
Output file

Analysis method: MCMC
save values at every 1000th cycle
Run 1010000 cycles
The first 10000 cycles are regarded as burn-in.

Character symbol

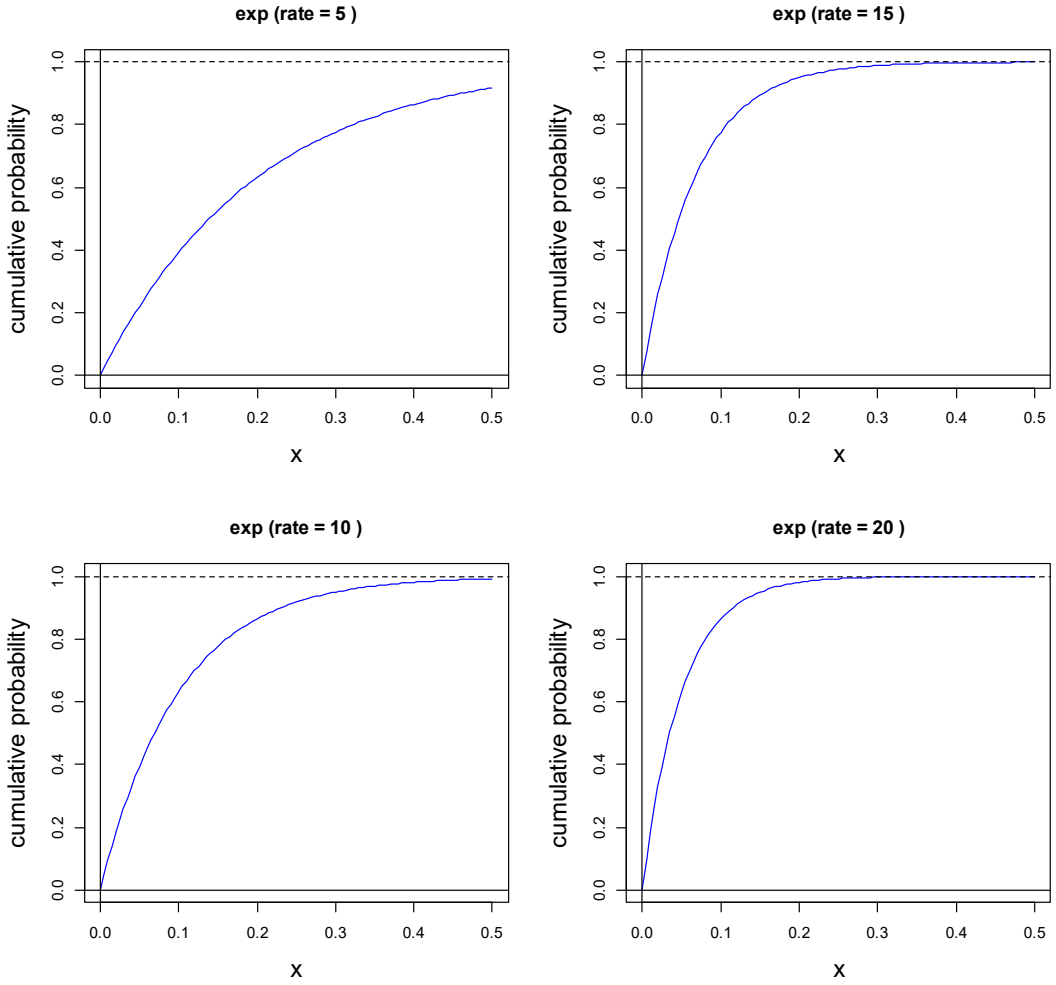
Restriction on the transition rate matrix
No restriction

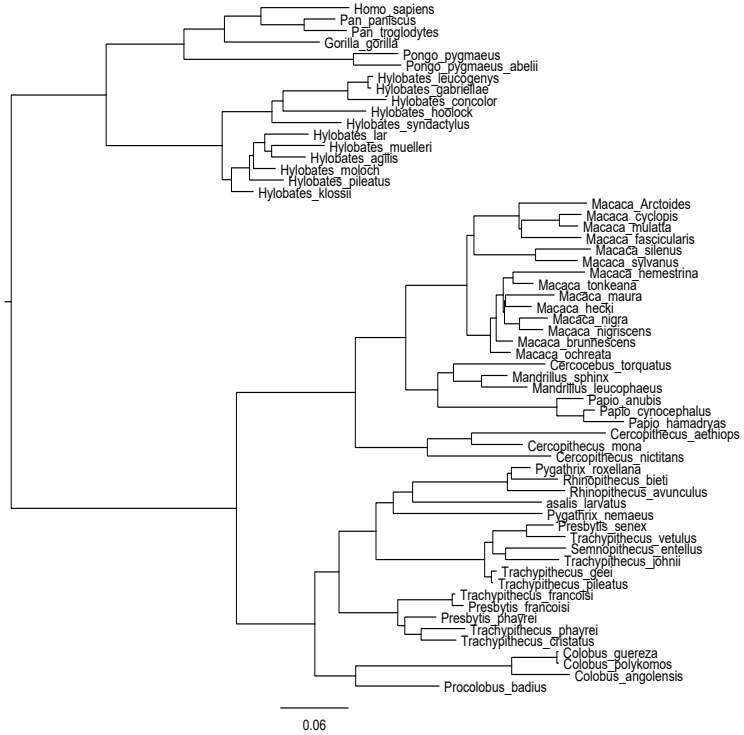
Prior distribution
unif[0-100] for qij's

The information on the trees

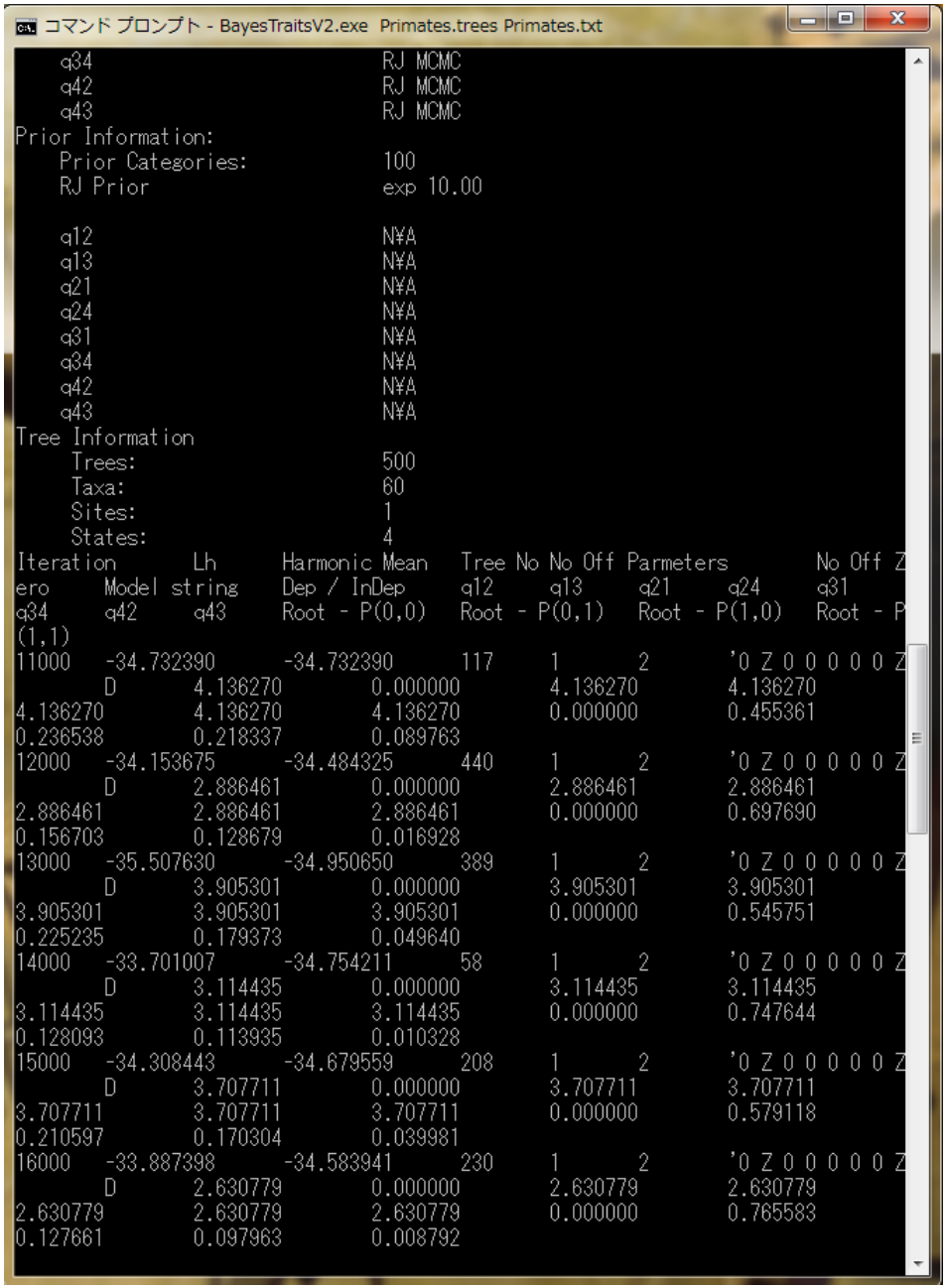
Write RevJump exp 10 and run

Exponential distribution

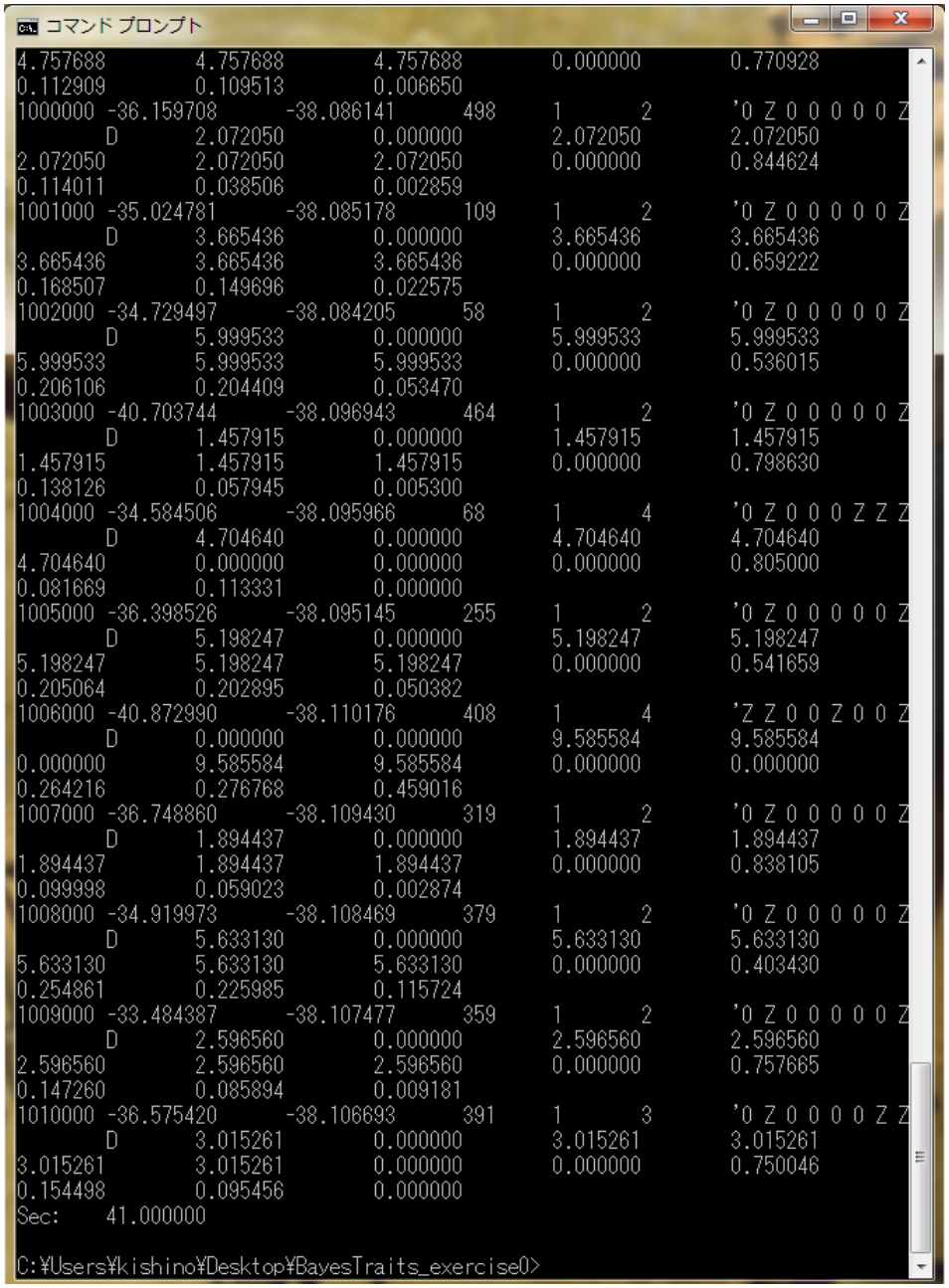




Reversible jump MCMC starts

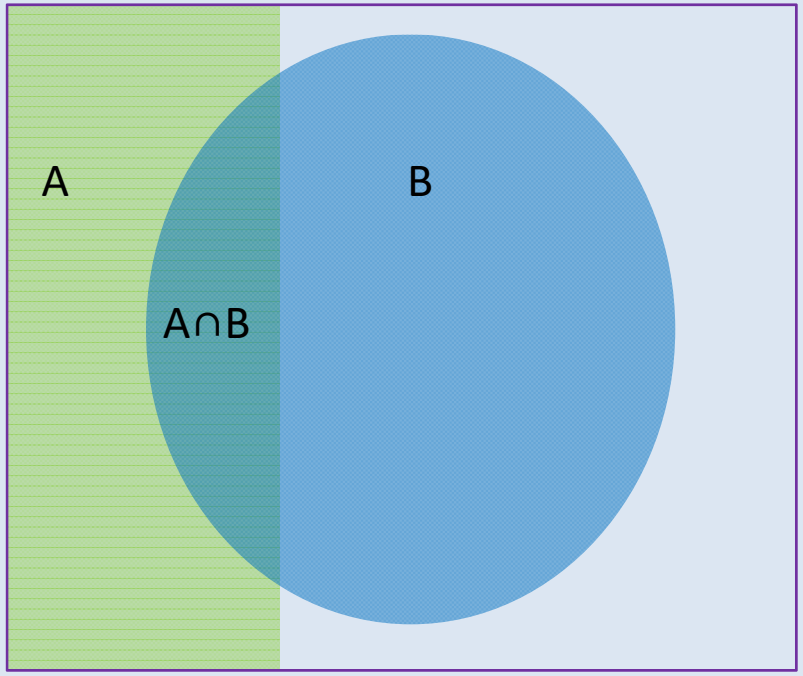


Done

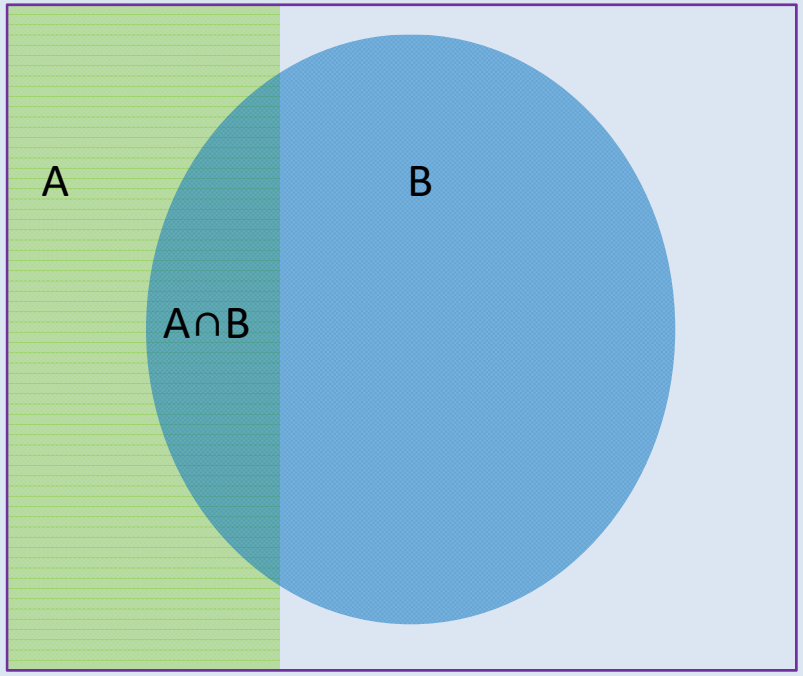

コマンド プロンプト
4.757688 4.757688 4.757688 0.000000 0.770928
0.112909 0.109513 0.006650
1000000 -36.159708 -38.086141 498 1 2 'O Z O O O O O Z
D 2.072050 0.000000 2.072050 2.072050
2.072050 2.072050 2.072050 0.000000 0.844624
0.114011 0.038506 0.002859
1001000 -35.024781 -38.085178 109 1 2 'O Z O O O O O Z
D 3.665436 0.000000 3.665436 3.665436
3.665436 3.665436 3.665436 0.000000 0.659222
0.168507 0.149696 0.022575
1002000 -34.729497 -38.084205 58 1 2 'O Z O O O O O Z
D 5.999533 0.000000 5.999533 5.999533
5.999533 5.999533 5.999533 0.000000 0.536015
0.206106 0.204409 0.053470
1003000 -40.703744 -38.096943 464 1 2 'O Z O O O O O Z
D 1.457915 0.000000 1.457915 1.457915
1.457915 1.457915 1.457915 0.000000 0.798630
0.138126 0.057945 0.005300
1004000 -34.584506 -38.095966 68 1 4 'O Z O O O Z Z Z
D 4.704640 0.000000 4.704640 4.704640
4.704640 0.000000 0.000000 0.000000 0.805000
0.081669 0.113331 0.000000
1005000 -36.398526 -38.095145 255 1 2 'O Z O O O O O Z
D 5.198247 0.000000 5.198247 5.198247
5.198247 5.198247 5.198247 0.000000 0.541659
0.205064 0.202895 0.050382
1006000 -40.872990 -38.110176 408 1 4 'Z Z O O Z O O Z
D 0.000000 0.000000 9.585584 9.585584
0.000000 9.585584 9.585584 0.000000 0.000000
0.264216 0.276768 0.459016
1007000 -36.748860 -38.109430 319 1 2 'O Z O O O O O Z
D 1.894437 0.000000 1.894437 1.894437
1.894437 1.894437 1.894437 0.000000 0.838105
0.099998 0.059023 0.002874
1008000 -34.919973 -38.108469 379 1 2 'O Z O O O O O Z
D 5.633130 0.000000 5.633130 5.633130
5.633130 5.633130 5.633130 0.000000 0.403430
0.254861 0.225985 0.115724
1009000 -33.484387 -38.107477 359 1 2 'O Z O O O O O Z
D 2.596560 0.000000 2.596560 2.596560
2.596560 2.596560 2.596560 0.000000 0.757665
0.147260 0.085894 0.009181
1010000 -36.575420 -38.106693 391 1 3 'O Z O O O Z Z
D 3.015261 0.000000 3.015261 3.015261
3.015261 3.015261 0.000000 0.000000 0.750046
0.154498 0.095456 0.000000
Sec: 41.000000
C:¥Users¥kishino¥Desktop¥BayesTraits_exercise0>

[coffee break]
Bayesian inference and MCMC

Conditional probability and Bayes formula

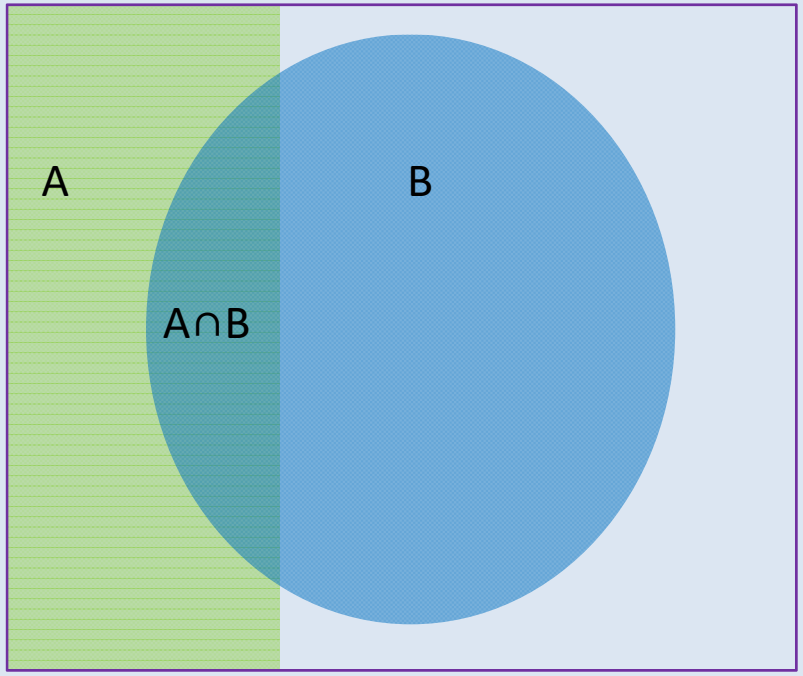


Conditional probability and Bayes formula



$$P(\mathrm{A} \cap \mathrm{B}) = P(\mathrm{A} \mid \mathrm{B})P(\mathrm{B}) = P(\mathrm{B} \mid \mathrm{A})P(\mathrm{A})$$

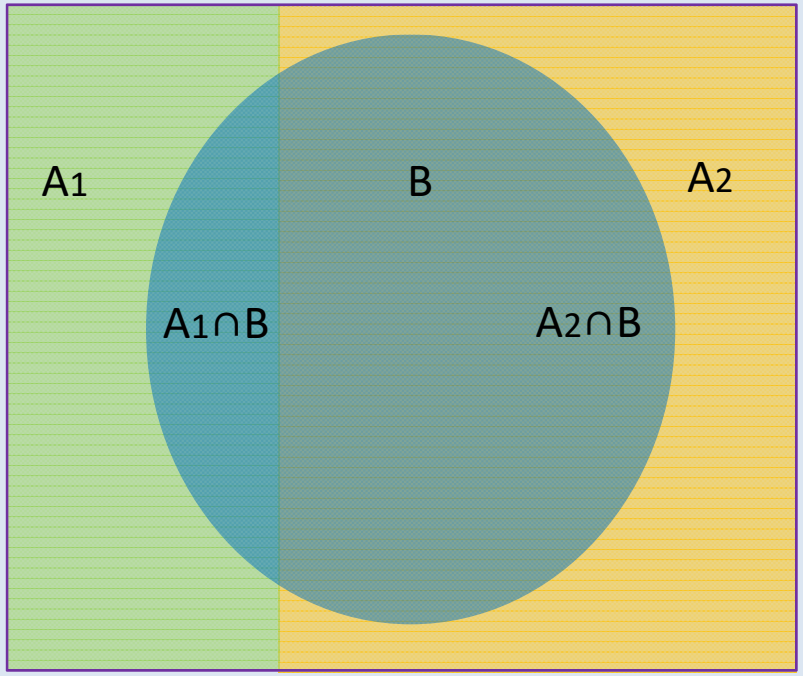
Conditional probability and Bayes formula



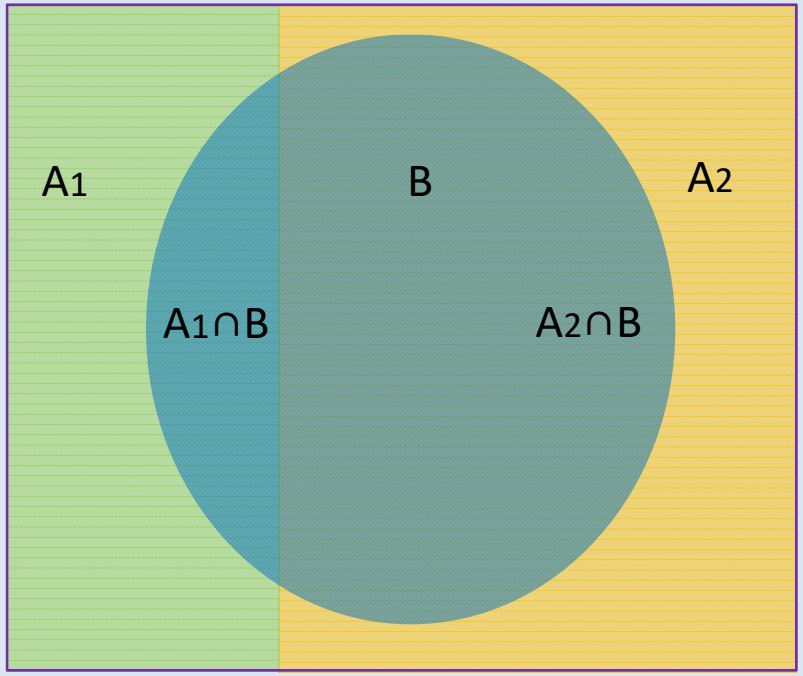
$$P(\mathrm{A} \cap \mathrm{B}) = P(\mathrm{A} \mid \mathrm{B})P(\mathrm{B}) = P(\mathrm{B} \mid \mathrm{A})P(\mathrm{A})$$

$$P(\mathrm{A} \mid \mathrm{B}) = \frac{P(\mathrm{B} \mid \mathrm{A})P(\mathrm{A})}{P(\mathrm{B})}$$

Conditional probability and Bayes formula



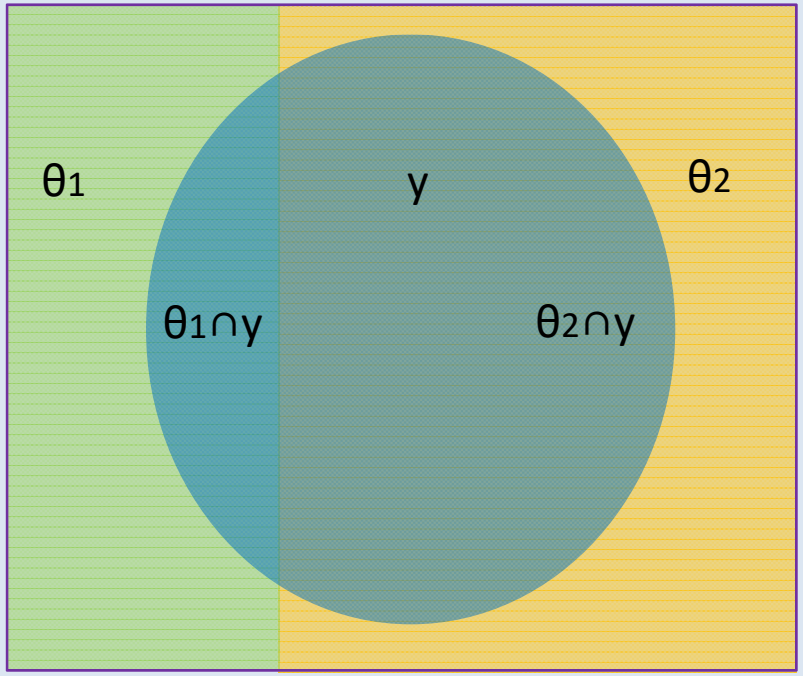
Conditional probability and Bayes formula



$$P(\mathrm{A}_1 \mid \mathrm{B}) = \frac{P(\mathrm{B} \mid \mathrm{A}_1)P(\mathrm{A}_1)}{P(\mathrm{B})}$$

$$P(\mathrm{A}_2 \mid \mathrm{B}) = \frac{P(\mathrm{B} \mid \mathrm{A}_2)P(\mathrm{A}_2)}{P(\mathrm{B})}$$

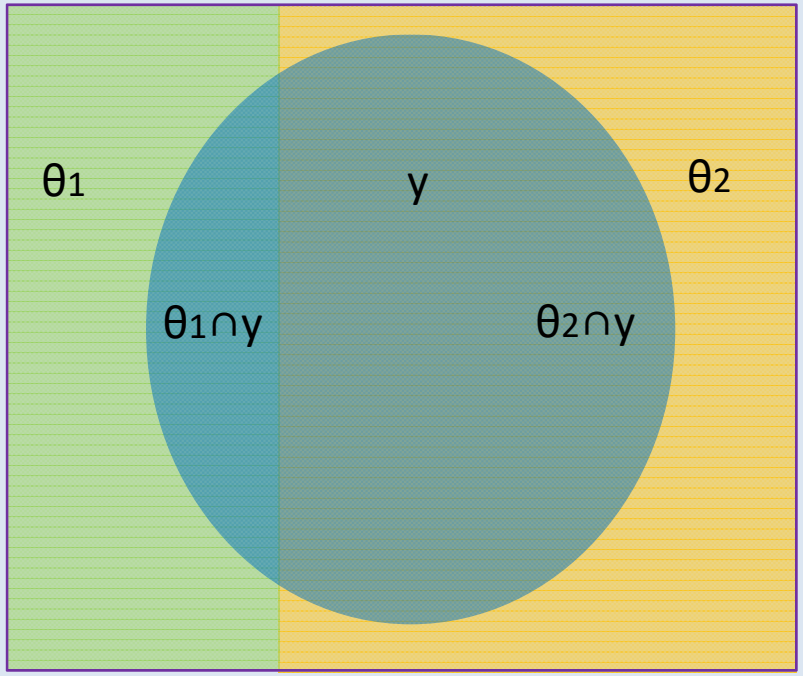
Conditional probability and Bayes formula



$$P(\theta_1 \mid \mathrm{y}) = \frac{P(\mathrm{y} \mid \theta_1)P(\theta_1)}{P(\mathrm{y})}$$

$$P(\theta_2 \mid \mathrm{y}) = \frac{P(\mathrm{y} \mid \theta_2)P(\theta_2)}{P(\mathrm{y})}$$

Conditional probability and Bayes formula

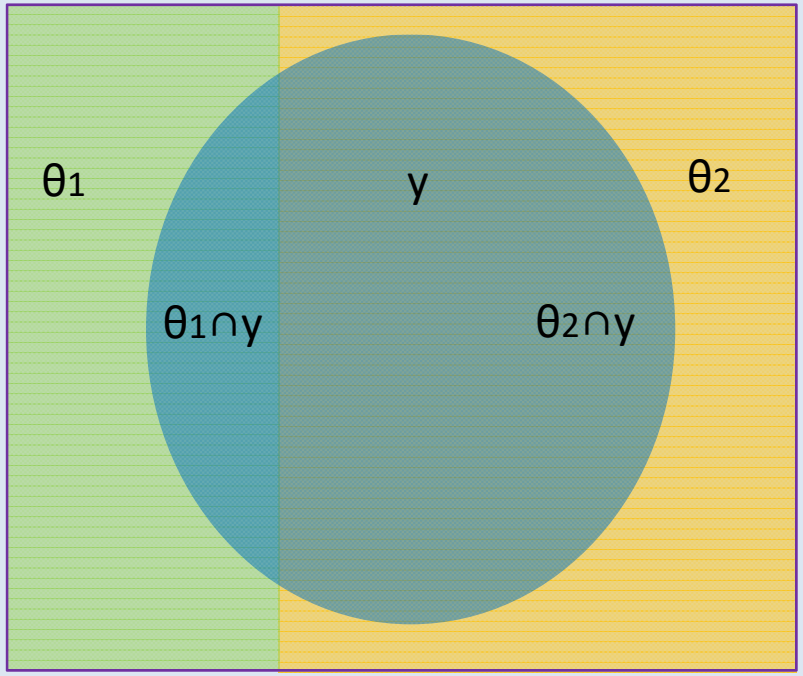


尤度

$$P(\theta_1 \mid y) = \frac{P(y \mid \theta_1)P(\theta_1)}{P(y)}$$

$$P(\theta_2 \mid y) = \frac{P(y \mid \theta_2)P(\theta_2)}{P(y)}$$

Conditional probability and Bayes formula

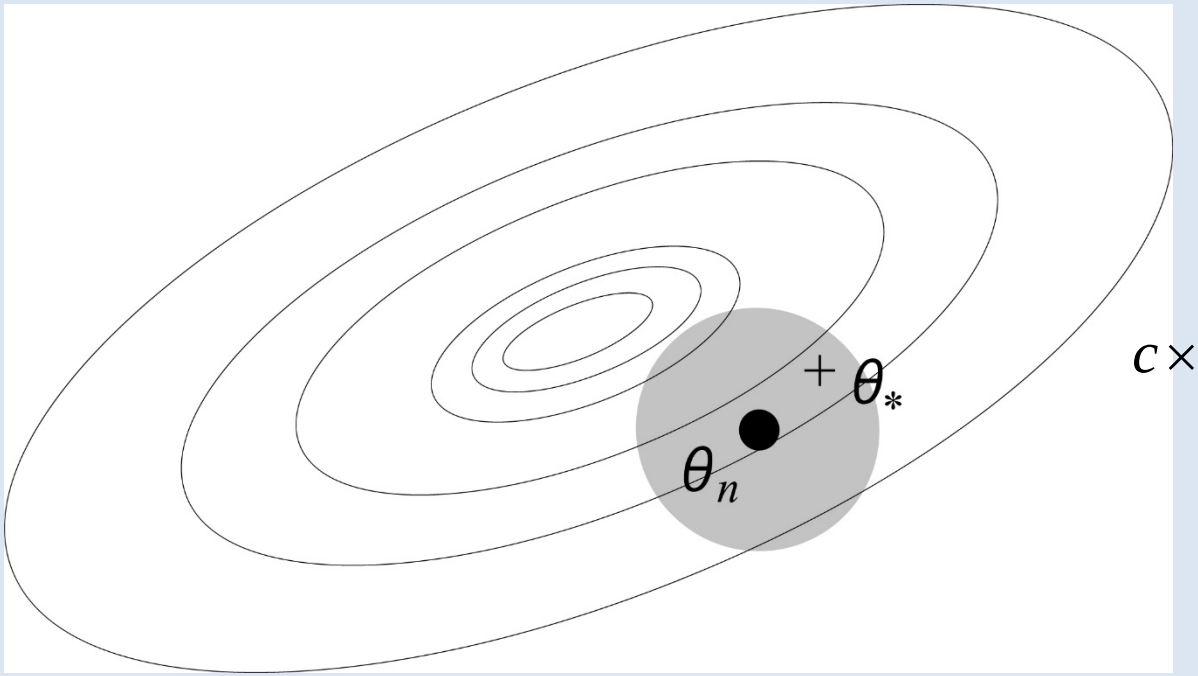


尤度　事前分布

$$P(\theta_1 \mid \mathrm{y}) = \frac{P(\mathrm{y} \mid \theta_1)P(\theta_1)}{P(\mathrm{y})}$$

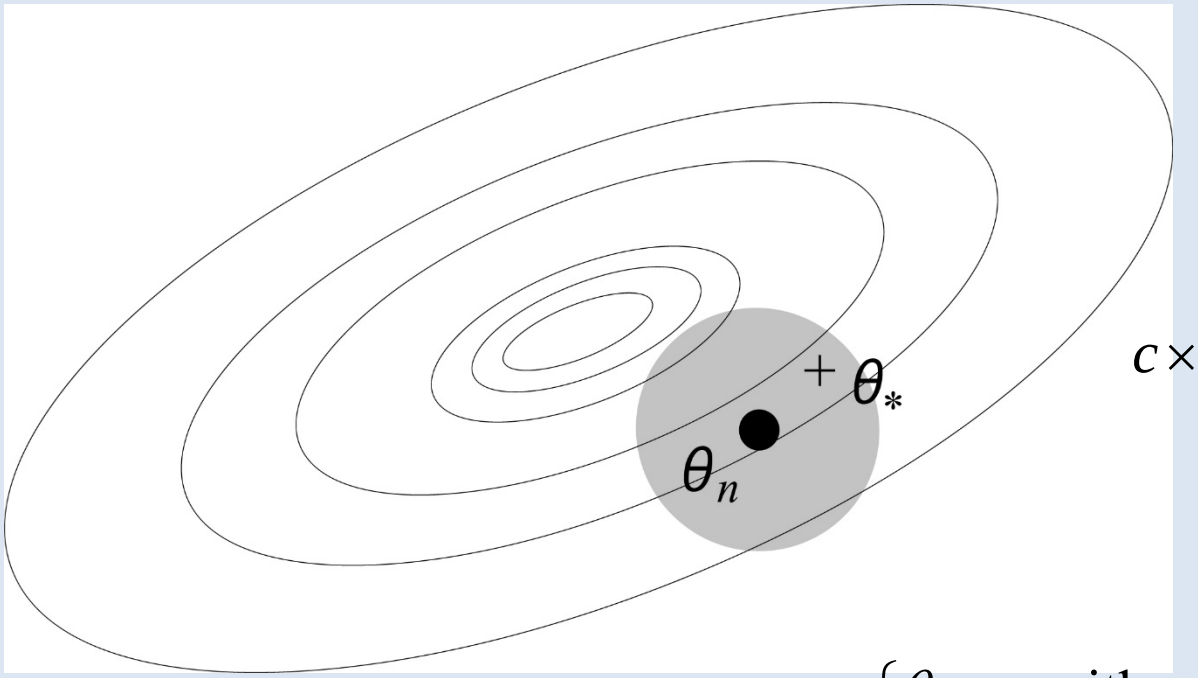
$$P(\theta_2 \mid \mathrm{y}) = \frac{P(\mathrm{y} \mid \theta_2)P(\theta_2)}{P(\mathrm{y})}$$

Simulating posterior distribution by Markov chain Monte Carlo (MCMC)



$$c \times p(y \mid \theta) p(\theta)$$

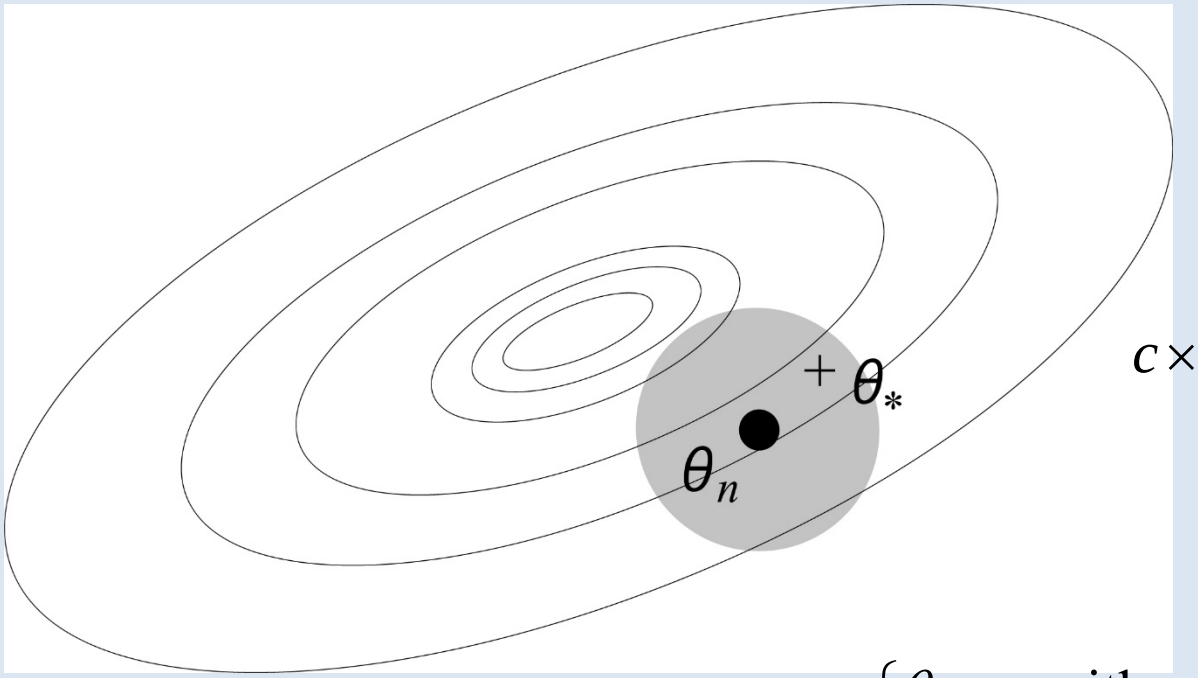
Simulating posterior distribution by Markov chain Monte Carlo (MCMC)



$$c \times p(y \mid \theta) p(\theta)$$

$$\theta_{n+1} = \begin{cases} \theta_* & \text{with probability } r \\ \theta_n & \text{with probability } 1 - r \end{cases}$$

Simulating posterior distribution by Markov chain Monte Carlo (MCMC)



$$c \times p(y \mid \theta) p(\theta)$$

$$\theta_{n+1} = \begin{cases} \theta_* & \text{with probability } r \\ \theta_n & \text{with probability } 1 - r \end{cases}$$

$$r = \min\left\{1, \frac{p(y \mid \theta_*) p(\theta_*)}{p(y \mid \theta_n) p(\theta_n)} \times \frac{h(\theta_n \mid \theta_*)}{h(\theta_* \mid \theta_n)}\right\}$$

MCMC by R

```
MCMC1 <- function(f,init,nsample,nthin,updatewidth){
  x <- NULL
  x0 <- init; y0 <- f(x0)
  for (i in 1:nsample){
    for (j in 1:nthin){
      x1 <- x0 + rnorm(1,sd=updatewidth)
      y1 <- f(x1)
      if(runif(1)<y1/y0) {x0 <- x1; y0 <- y1}
    }
    x <- c(x,x0)
  }
  x
 }
```

MCMC by R

```
MCMC1 <- function(f,init,nsample,nthin,updatewidth){
  x <- NULL
  x0 <- init; y0 <- f(x0)
  for (i in 1:nsample){
    for (j in 1:nthin){
      x1 <- x0 + rnorm(1,sd=updatewidt)
      y1 <- f(x1)
      if(runif(1)<y1/y0) {x0 <- x1; y0 <- y1}
    }
    x <- c(x,x0)
  }
  x
 }
```

MCMC by R

```
MCMC1 <- function(f,init,nsample,nthin,updatewidth){
  x <- NULL
  x0 <- init; y0 <- f(x0)
  for (i in 1:nsample){
    for (j in 1:nthin){
      x1 <- x0 + rnorm(1,sd=updatewidt)
      y1 <- f(x1)
      if(runif(1)<y1/y0) {x0 <- x1; y0 <- y1}
    }
    x <- c(x,x0)
  }
  x
 }
```

init	Initial value
nsample	Sample size to be simulated
nthin	Size of thinning to save the memory
updatewidth	Width for the proposal step
nburin	Burn-in period to be discarded from the sample

MCMC by R

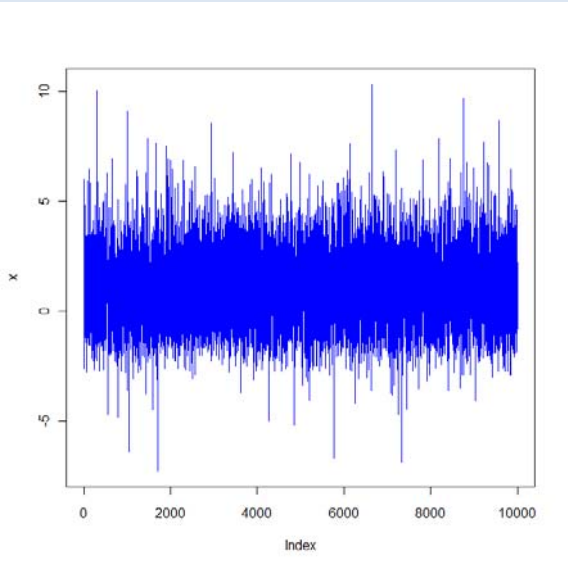
```
func <- function(x){exp(-(x+1)^2)+3*exp(-abs(x-2))}
```

MCMC by R

```
func <- function(x){exp(-(x+1)^2)+3*exp(-abs(x-2))}

x <- MCMC1(func,0,10000,10,2)
```

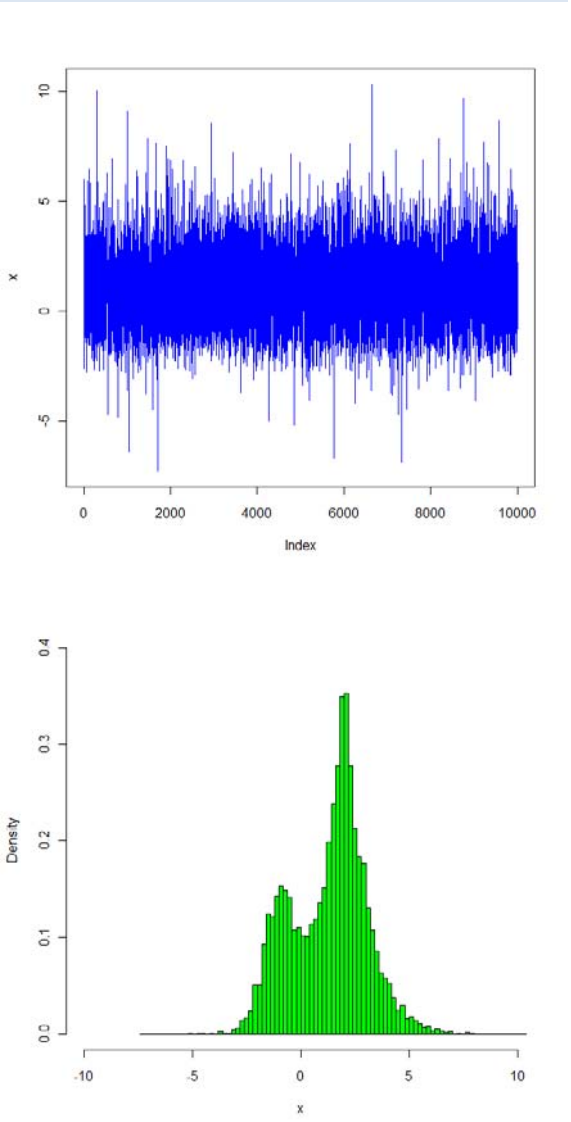
MCMC by R

```
func <- function(x){exp(-(x+1)^2)+3*exp(-abs(x-2))}

x <- MCMC1(func,0,10000,10,2)

plot(x,type="l",col="blue")
```



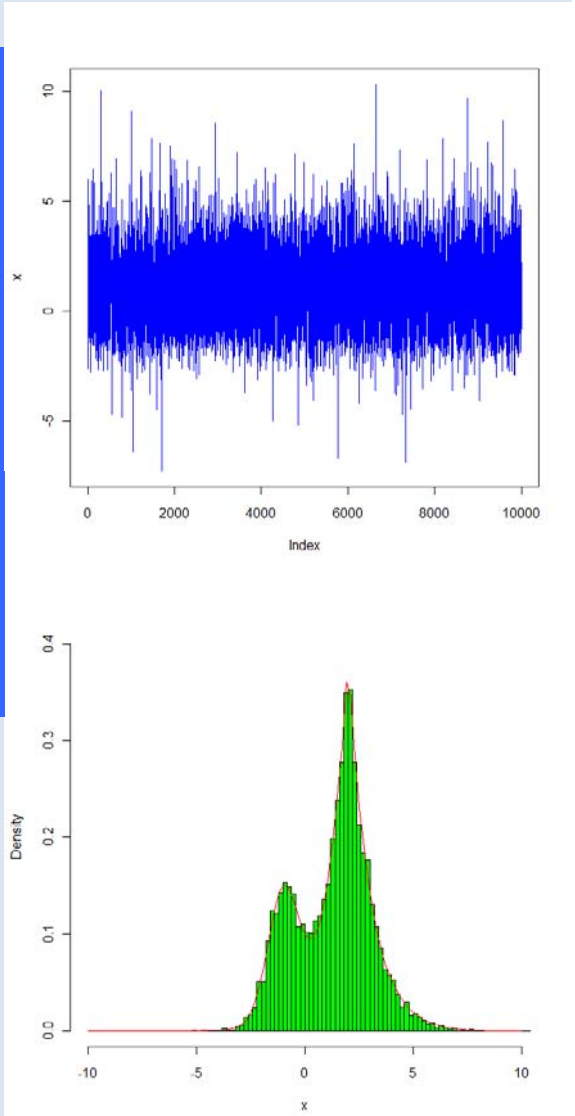
MCMC by R

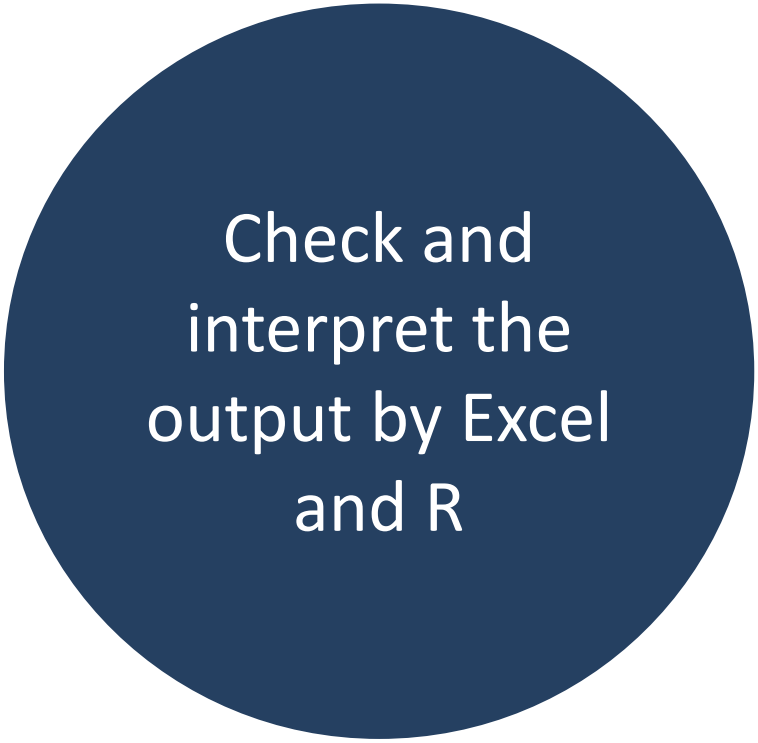
```
func <- function(x){exp(-(x+1)^2)+3*exp(-abs(x-2))}

x <- MCMC1(func,0,10000,10,2)

plot(x,type="l",col="blue")

hist(x,probability=T,nclass=100,
     xlim=c(-10,10),ylim=c(0,0.4),col="green")
```



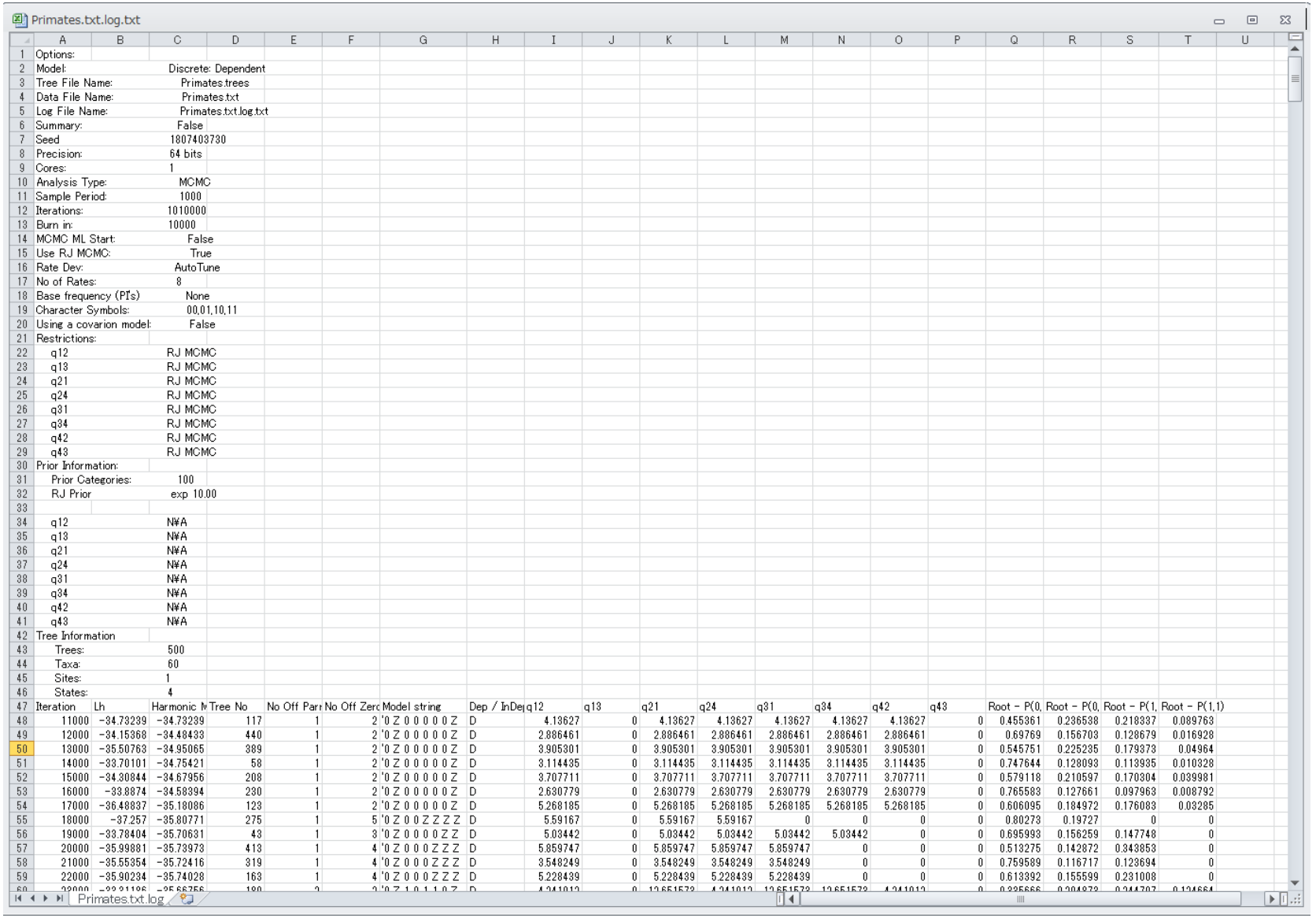
MCMC by R

```
func <- function(x){exp(-(x+1)^2)+3*exp(-abs(x-2))}

x <- MCMC1(func,0,10000,10,2)

plot(x,type="l",col="blue")

hist(x,probability=T,nclass=100,
     xlim=c(-10,10),ylim=c(0,0.4),col="green")

z <- seq(-10,10,length=100)
ftot <- 0
for (t in z) {ftot <- ftot+func(t)*20/100}
lines(z,func(z)/ftot,col="red")
```




Check and
interpret the
output by Excel
and R

Open the output file (Primates.txt.log.txt) by excel



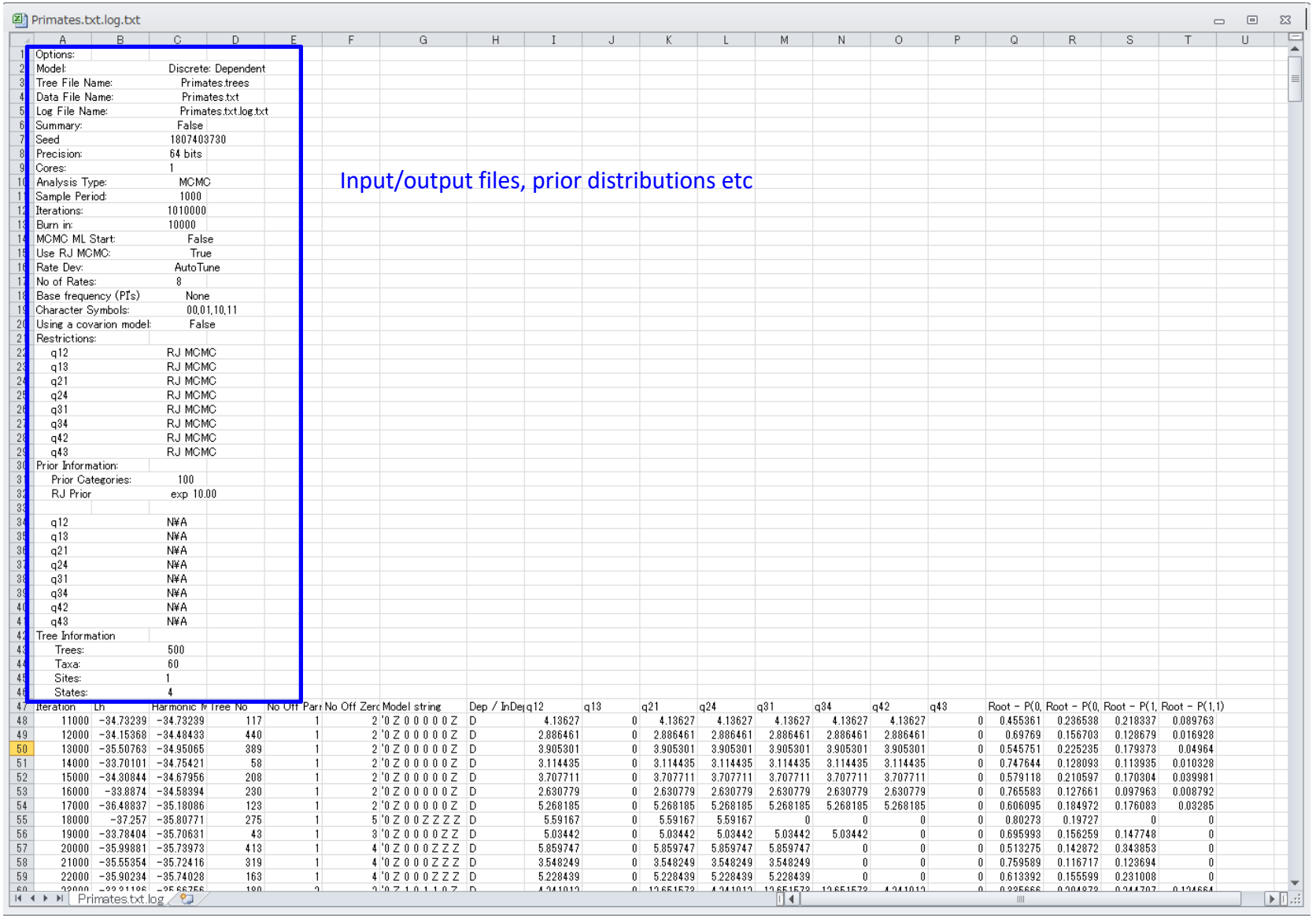
Primates.txt.log.txt

Options:		
Model:	Discrete: Dependent	
Tree File Name:	Primates.trees	
Data File Name:	Primates.txt	
Log File Name:	Primates.txt.log.txt	
Summary:	False	
Seed	1807403730	
Precision:	64 bits	
Cores:	1	
Analysis Type:	MCMC	
Sample Period:	1000	
Iterations:	1010000	
Burn in:	10000	
MCMC ML Start:	False	
Use RJ MCMC:	True	
Rate Dev:	AutoTune	
No of Rates:	8	
Base frequency (Pi's)	None	
Character Symbols:	00,01,10,11	
Using a covarion model:	False	
Restrictions:		
q12	RJ MCMC	
q13	RJ MCMC	
q21	RJ MCMC	
q24	RJ MCMC	
q31	RJ MCMC	
q34	RJ MCMC	
q42	RJ MCMC	
q43	RJ MCMC	
Prior Information:		
Prior Categories:	100	
RJ Prior	exp 10.00	
q12	N¥A	
q13	N¥A	
q21	N¥A	
q24	N¥A	
q31	N¥A	
q34	N¥A	
q42	N¥A	
q43	N¥A	
Tree Information		
Trees:	500	
Taxa:	60	
Sites:	1	
States:	4	

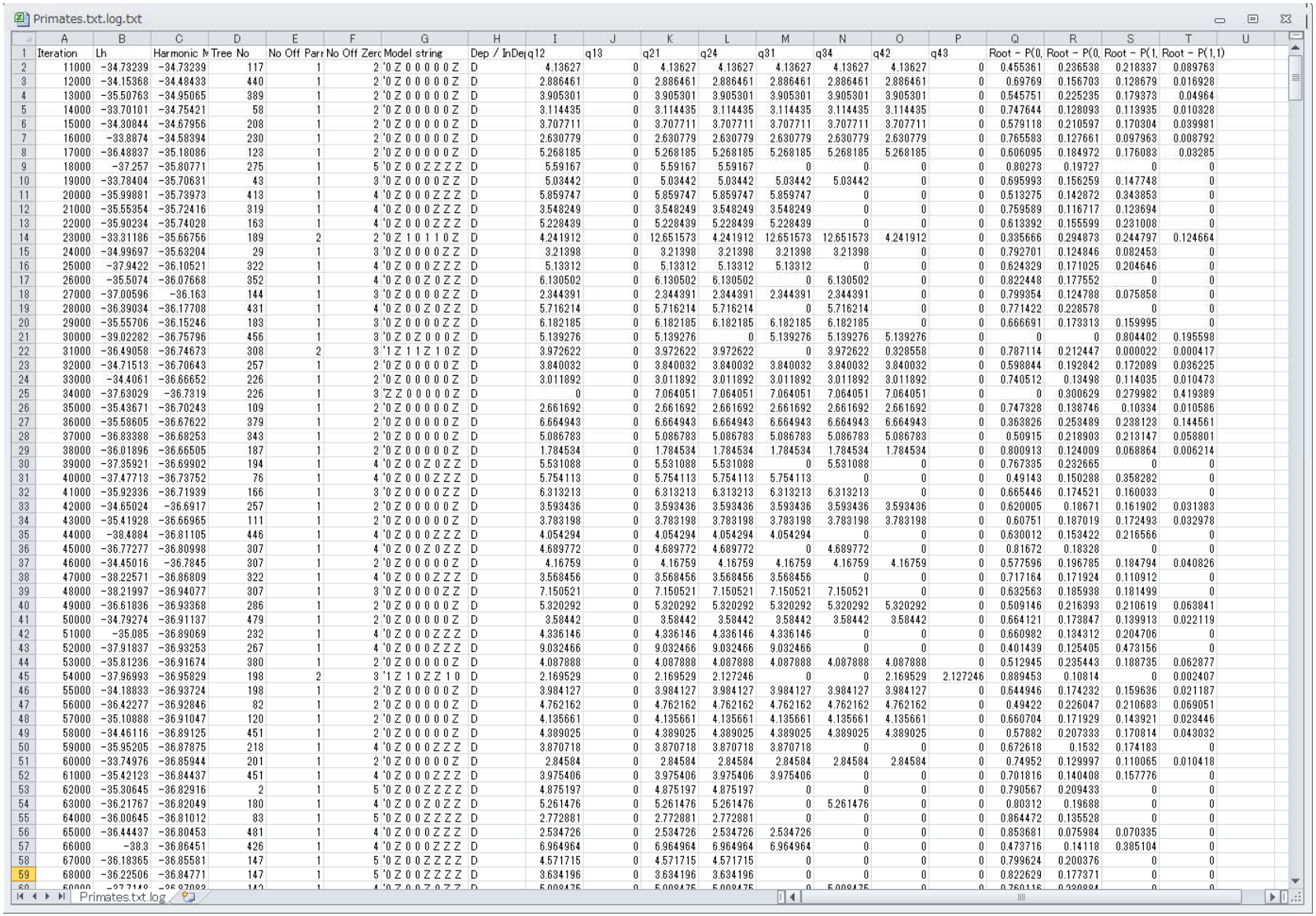
Iteration	Lh	Harmonic M	Tree No	No Off Parr	No Off Zerc	Model string	Dep / InDep	q12	q13	q21	q24	q31	q34	q42	q43	Root - P(0,	Root - P(0,	Root - P(1,	Root - P(1,1)
11000	-34.73239	-34.73239	117	1	2	'0 Z 0 0 0 0 0 Z	D	4.13627	0	4.13627	4.13627	4.13627	4.13627	4.13627	0	0.455361	0.236538	0.218337	0.089763
12000	-34.15368	-34.48433	440	1	2	'0 Z 0 0 0 0 0 Z	D	2.886461	0	2.886461	2.886461	2.886461	2.886461	2.886461	0	0.69769	0.156703	0.128679	0.016928
13000	-35.50763	-34.95065	389	1	2	'0 Z 0 0 0 0 0 Z	D	3.905301	0	3.905301	3.905301	3.905301	3.905301	3.905301	0	0.545751	0.225235	0.179373	0.04964
14000	-33.70101	-34.75421	58	1	2	'0 Z 0 0 0 0 0 Z	D	3.114435	0	3.114435	3.114435	3.114435	3.114435	3.114435	0	0.747644	0.128093	0.113935	0.010328
15000	-34.30844	-34.67956	208	1	2	'0 Z 0 0 0 0 0 Z	D	3.707711	0	3.707711	3.707711	3.707711	3.707711	3.707711	0	0.579118	0.210597	0.170304	0.039981
16000	-33.8874	-34.58394	230	1	2	'0 Z 0 0 0 0 0 Z	D	2.630779	0	2.630779	2.630779	2.630779	2.630779	2.630779	0	0.765583	0.127661	0.097963	0.008792
17000	-36.48837	-35.18086	123	1	2	'0 Z 0 0 0 0 0 Z	D	5.268185	0	5.268185	5.268185	5.268185	5.268185	5.268185	0	0.606095	0.184972	0.176083	0.03285
18000	-37.257	-35.80771	275	1	5	'0 Z 0 0 Z Z Z Z	D	5.59167	0	5.59167	5.59167	0	0	0	0	0.80273	0.19727	0	0
19000	-33.78404	-35.70631	43	1	3	'0 Z 0 0 0 0 Z Z	D	5.03442	0	5.03442	5.03442	5.03442	5.03442	0	0	0.695993	0.156259	0.147748	0
20000	-35.99881	-35.73973	413	1	4	'0 Z 0 0 0 Z Z Z	D	5.859747	0	5.859747	5.859747	5.859747	0	0	0	0.513275	0.142872	0.343853	0
21000	-35.55354	-35.72416	319	1	4	'0 Z 0 0 0 Z Z Z	D	3.548249	0	3.548249	3.548249	3.548249	0	0	0	0.759589	0.116717	0.123694	0
22000	-35.90234	-35.74028	163	1	4	'0 Z 0 0 0 Z Z Z	D	5.228439	0	5.228439	5.228439	5.228439	0	0	0	0.613392	0.155599	0.231008	0
23000	-33.21186	-35.66756	180	2	3	'0 Z 1 0 1 1 0 Z	D	4.241012	0	12.651573	4.241012	12.651573	12.651573	4.241012	0	0.295666	0.204972	0.344707	0.154664

Primates.txt.log

Open the output file (Primates.txt.log.txt) by excel



Keep only the data of MCMC sample (for R)

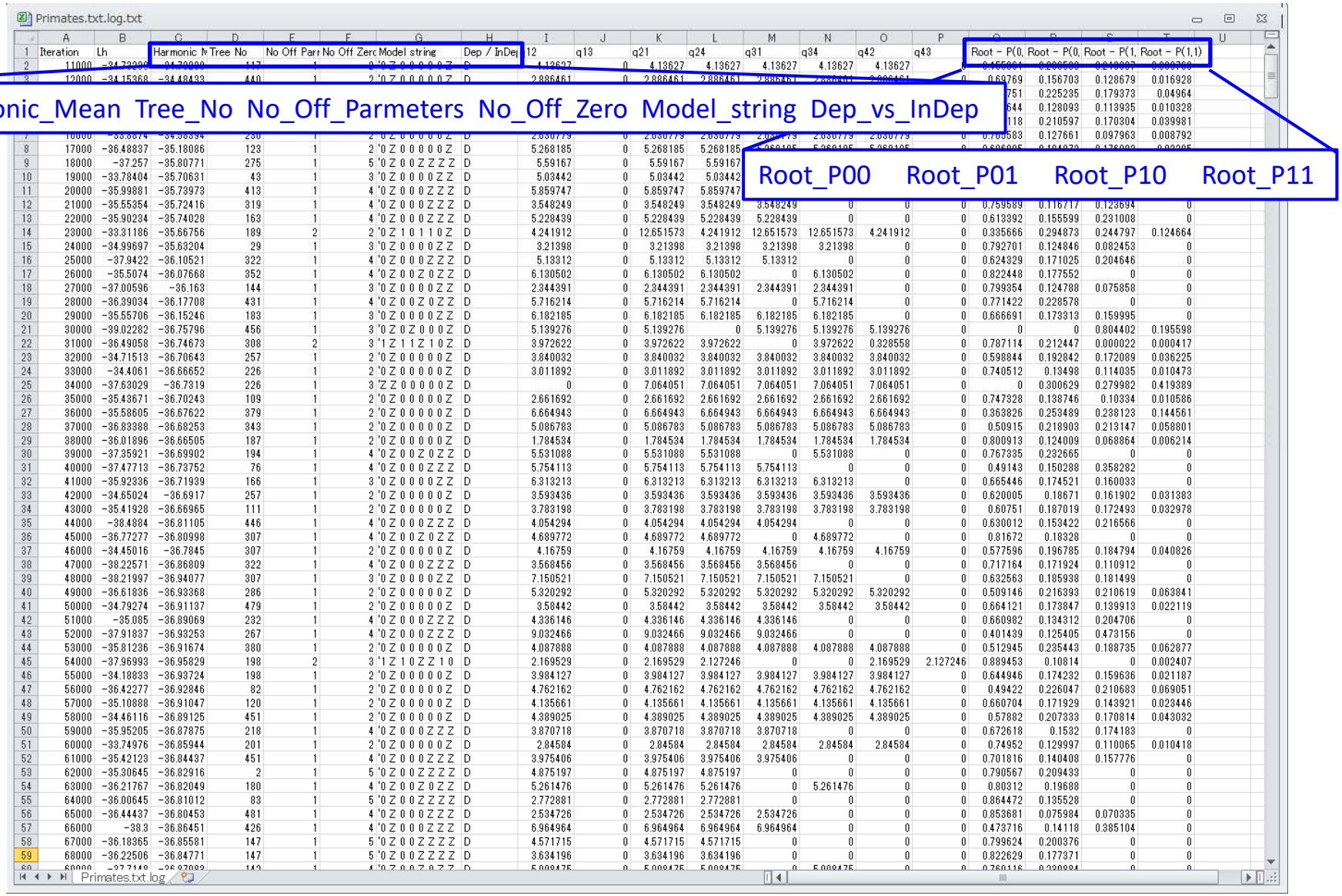


Primates.txt.log.txt

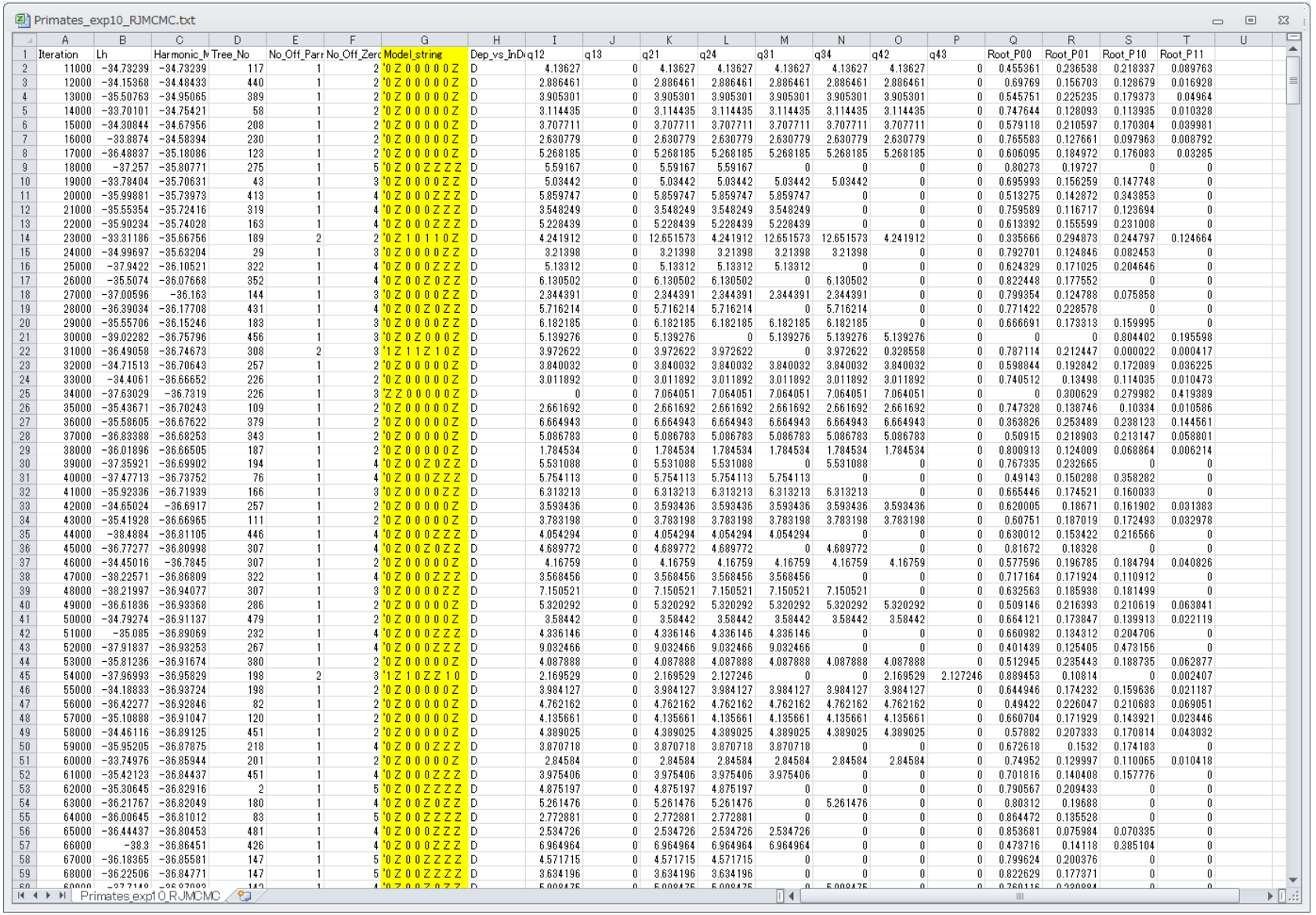
	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Iteration	Lh	Harmonic M	Tree No	No Off Parr	No Off Zerc	Model string	Dep / InDep	q12	q13	q21	q24	q31	q34	q42	q43	Root - P(0,	Root - P(0,	Root - P(1,	Root - P(1,1)	
2	11000	-34.73239	-34.73239	117	1	2	'0 Z 0 0 0 0 0 Z	D	4.13627	0	4.13627	4.13627	4.13627	4.13627	4.13627	0	0.455361	0.236538	0.218337	0.089763	
3	12000	-34.15368	-34.48433	440	1	2	'0 Z 0 0 0 0 0 Z	D	2.886461	0	2.886461	2.886461	2.886461	2.886461	2.886461	0	0.69769	0.156703	0.128679	0.016928	
4	13000	-35.50763	-34.95065	389	1	2	'0 Z 0 0 0 0 0 Z	D	3.905301	0	3.905301	3.905301	3.905301	3.905301	3.905301	0	0.545751	0.225235	0.179373	0.04964	
5	14000	-33.70101	-34.75421	58	1	2	'0 Z 0 0 0 0 0 Z	D	3.114435	0	3.114435	3.114435	3.114435	3.114435	3.114435	0	0.747644	0.128093	0.113935	0.010328	
6	15000	-34.30844	-34.67956	208	1	2	'0 Z 0 0 0 0 0 Z	D	3.707711	0	3.707711	3.707711	3.707711	3.707711	3.707711	0	0.579118	0.210597	0.170304	0.039981	
7	16000	-33.8874	-34.58394	230	1	2	'0 Z 0 0 0 0 0 Z	D	2.630779	0	2.630779	2.630779	2.630779	2.630779	2.630779	0	0.765583	0.127661	0.097963	0.008792	
8	17000	-36.48837	-35.18086	123	1	2	'0 Z 0 0 0 0 0 Z	D	5.268185	0	5.268185	5.268185	5.268185	5.268185	5.268185	0	0.606095	0.184972	0.176083	0.03285	
9	18000	-37.257	-35.80771	275	1	5	'0 Z 0 0 Z Z Z Z	D	5.59167	0	5.59167	5.59167	0	0	0	0	0.80273	0.19727	0	0	
10	19000	-33.78404	-35.70631	43	1	3	'0 Z 0 0 0 0 Z Z	D	5.03442	0	5.03442	5.03442	5.03442	5.03442	0	0	0.695993	0.156259	0.147748	0	
11	20000	-35.99881	-35.73973	413	1	4	'0 Z 0 0 0 Z Z Z	D	5.859747	0	5.859747	5.859747	5.859747	0	0	0	0.513275	0.142872	0.343853	0	
12	21000	-35.55354	-35.72416	319	1	4	'0 Z 0 0 0 Z Z Z	D	3.548249	0	3.548249	3.548249	3.548249	0	0	0	0.759589	0.116717	0.123694	0	
13	22000	-35.90234	-35.74028	163	1	4	'0 Z 0 0 0 Z Z Z	D	5.228439	0	5.228439	5.228439	5.228439	0	0	0	0.613392	0.155599	0.231008	0	
14	23000	-33.31186	-35.66756	189	2	2	'0 Z 1 0 1 1 0 Z	D	4.241912	0	12.651573	4.241912	12.651573	12.651573	4.241912	0	0.335666	0.294873	0.244797	0.124664	
15	24000	-34.99697	-35.63204	29	1	3	'0 Z 0 0 0 0 Z Z	D	3.21398	0	3.21398	3.21398	3.21398	3.21398	0	0	0.792701	0.124846	0.082453	0	
16	25000	-37.9422	-36.10521	322	1	4	'0 Z 0 0 0 Z Z Z	D	5.13312	0	5.13312	5.13312	5.13312	0	0	0	0.624329	0.171025	0.204646	0	
17	26000	-35.5074	-36.07668	352	1	4	'0 Z 0 0 Z 0 Z Z	D	6.130502	0	6.130502	6.130502	0	6.130502	0	0	0.822448	0.177552	0	0	
18	27000	-37.00596	-36.163	144	1	3	'0 Z 0 0 0 0 Z Z	D	2.344391	0	2.344391	2.344391	2.344391	0	0	0	0.799354	0.124788	0.075858	0	
19	28000	-36.39034	-36.17708	431	1	4	'0 Z 0 0 Z 0 Z Z	D	5.716214	0	5.716214	5.716214	0	5.716214	0	0	0.771422	0.228578	0	0	
20	29000	-35.55706	-36.15246	183	1	3	'0 Z 0 0 0 0 Z Z	D	6.182185	0	6.182185	6.182185	6.182185	6.182185	0	0	0.666691	0.173313	0.159995	0	
21	30000	-39.02282	-36.75796	456	1	3	'0 Z 0 Z 0 0 0 Z	D	5.139276	0	5.139276	0	5.139276	5.139276	5.139276	0	0	0	0.804402	0.195598	
22	31000	-36.49058	-36.74673	308	2	3	'1 Z 1 1 Z 1 0 Z	D	3.972622	0	3.972622	3.972622	0	3.972622	0.328558	0	0.787114	0.212447	0.000022	0.000417	
23	32000	-34.71513	-36.70643	257	1	2	'0 Z 0 0 0 0 0 Z	D	3.840032	0	3.840032	3.840032	3.840032	3.840032	3.840032	0	0.598844	0.192842	0.172089	0.036225	
24	33000	-34.4061	-36.66652	226	1	2	'0 Z 0 0 0 0 0 Z	D	3.011892	0	3.011892	3.011892	3.011892	3.011892	3.011892	0	0.740512	0.13498	0.114035	0.010473	
25	34000	-37.63029	-36.7319	226	1	3	'Z Z 0 0 0 0 0 Z	D	0	0	7.064051	7.064051	7.064051	7.064051	7.064051	0	0	0.300629	0.279982	0.419389	
26	35000	-35.43671	-36.70243	109	1	2	'0 Z 0 0 0 0 0 Z	D	2.661692	0	2.661692	2.661692	2.661692	2.661692	2.661692	0	0.747328	0.138746	0.10334	0.010586	
27	36000	-35.58605	-36.67622	379	1	2	'0 Z 0 0 0 0 0 Z	D	6.664943	0	6.664943	6.664943	6.664943	6.664943	6.664943	0	0.363826	0.253489	0.238123	0.144561	
28	37000	-36.83388	-36.68253	343	1	2	'0 Z 0 0 0 0 0 Z	D	5.086783	0	5.086783	5.086783	5.086783	5.086783	5.086783	0	0.50915	0.218903	0.213147	0.058801	
29	38000	-36.01896	-36.66505	187	1	2	'0 Z 0 0 0 0 0 Z	D	1.784534	0	1.784534	1.784534	1.784534	1.784534	1.784534	0	0.800913	0.124009	0.068864	0.006214	
30	39000	-37.35921	-36.69902	194	1	4	'0 Z 0 0 Z 0 Z Z	D	5.531088	0	5.531088	5.531088	0	5.531088	0	0	0.767335	0.232665	0	0	
31	40000	-37.47713	-36.73752	76	1	4	'0 Z 0 0 0 Z Z Z	D	5.754113	0	5.754113	5.754113	5.754113	0	0	0	0.49143	0.150288	0.358282	0	
32	41000	-35.92336	-36.71939	166	1	3	'0 Z 0 0 0 Z Z	D	6.313213	0	6.313213	6.313213	6.313213	0	0	0	0.665446	0.174521	0.160033	0	
33	42000	-34.65024	-36.6917	257	1	2	'0 Z 0 0 0 0 0 Z	D	3.593436	0	3.593436	3.593436	3.593436	3.593436	3.593436	0	0.620005	0.18671	0.161902	0.031383	
34	43000	-35.41928	-36.66965	111	1	2	'0 Z 0 0 0 0 0 Z	D	3.783198	0	3.783198	3.783198	3.783198	3.783198	3.783198	0	0.60751	0.187019	0.172493	0.032978	
35	44000	-38.4884	-36.81105	446	1	4	'0 Z 0 0 0 Z Z Z	D	4.054294	0	4.054294	4.054294	4.054294	0	0	0	0.630012	0.153422	0.216566	0	
36	45000	-36.77277	-36.80998	307	1	4	'0 Z 0 0 Z 0 Z Z	D	4.689772	0	4.689772	4.689772	0	4.689772	0	0	0.81672	0.18328	0	0	
37	46000	-34.45016	-36.7845	307	1	2	'0 Z 0 0 0 0 0 Z	D	4.16759	0	4.16759	4.16759	4.16759	4.16759	4.16759	0	0.577596	0.196785	0.184794	0.040826	
38	47000	-38.22571	-36.86809	322	1	4	'0 Z 0 0 0 Z Z Z	D	3.568456	0	3.568456	3.568456	3.568456	0	0	0	0.717164	0.171924	0.110912	0	
39	48000	-38.21997	-36.94077	307	1	3	'0 Z 0 0 0 0 Z Z	D	7.150521	0	7.150521	7.150521	7.150521	7.150521	0	0	0.632563	0.185938	0.181499	0	
40	49000	-36.61836	-36.93368	286	1	2	'0 Z 0 0 0 0 0 Z	D	5.320292	0	5.320292	5.320292	5.320292	5.320292	5.320292	0	0.509146	0.216393	0.210619	0.063841	
41	50000	-34.79274	-36.91137	479	1	2	'0 Z 0 0 0 0 0 Z	D	3.58442	0	3.58442	3.58442	3.58442	3.58442	3.58442	0	0.664121	0.173847	0.139913	0.022119	
42	51000	-35.085	-36.89069	232	1	4	'0 Z 0 0 0 Z Z Z	D	4.336146	0	4.336146	4.336146	4.336146	0	0	0	0.660982	0.134312	0.204706	0	
43	52000	-37.91837	-36.93253	267	1	4	'0 Z 0 0 0 Z Z Z	D	9.032466	0	9.032466	9.032466	9.032466	0	0	0	0.401439	0.125405	0.473156	0	
44	53000	-35.81236	-36.91674	380	1	2	'0 Z 0 0 0 0 0 Z	D	4.087888	0	4.087888	4.087888	4.087888	4.087888	4.087888	0	0.512945	0.235443	0.188735	0.062877	
45	54000	-37.96993	-36.95829	198	2	3	'1 Z 1 0 Z Z 1 0	D	2.169529	0	2.169529	2.127246	0	0	2.169529	2.127246	0.889453	0.10814	0	0.002407	
46	55000	-34.18833	-36.93724	198	1	2	'0 Z 0 0 0 0 0 Z	D	3.984127	0	3.984127	3.984127	3.984127	3.984127	3.984127	0	0.644946	0.174232	0.159636	0.021187	
47	56000	-36.42277	-36.92846	82	1	2	'0 Z 0 0 0 0 0 Z	D	4.762162	0	4.762162	4.762162	4.762162	4.762162	4.762162	0	0.49422	0.226047	0.210683	0.069051	
48	57000	-35.10888	-36.91047	120	1	2	'0 Z 0 0 0 0 0 Z	D	4.135661	0	4.135661	4.135661	4.135661	4.135661	4.135661	0	0.660704	0.171929	0.143921	0.023446	
49	58000	-34.46116	-36.89125	451	1	2	'0 Z 0 0 0 0 0 Z	D	4.389025	0	4.389025	4.389025	4.389025	4.389025	4.389025	0	0.57882	0.207333	0.170814	0.043032	
50	59000	-35.95205	-36.87875	218	1	4	'0 Z 0 0 0 Z Z Z	D	3.870718	0	3.870718	3.870718	3.870718	0	0	0	0.672618	0.1532	0.174183	0	
51	60000	-33.74976	-36.85944	201	1	2	'0 Z 0 0 0 0 0 Z	D	2.84584	0	2.84584	2.84584	2.84584	2.84584	2.84584	0	0.74952	0.129997	0.110065	0.010418	
52	61000	-35.42123	-36.84437	451	1	4	'0 Z 0 0 0 Z Z Z	D	3.975406	0	3.975406	3.975406	3.975406	0	0	0	0.701816	0.140408	0.157776	0	
53	62000	-35.30645	-36.82916	2	1	5	'0 Z 0 0 Z Z Z Z	D	4.875197	0	4.875197	4.875197	0	0	0	0	0.790567	0.209433	0	0	
54	63000	-36.21767	-36.82049	180	1	4	'0 Z 0 0 Z 0 Z Z	D	5.261476	0	5.261476	5.261476	0	5.261476	0	0	0.80312	0.19688	0	0	
55	64000	-36.00645	-36.81012	83	1	5	'0 Z 0 0 Z Z Z Z	D	2.772881	0	2.772881	2.772881	0	0	0	0	0.864472	0.135528	0	0	
56	65000	-36.44437	-36.80453	481	1	4	'0 Z 0 0 0 Z Z Z	D	2.534726	0	2.534726	2.534726	2.534726	0	0	0	0.853681	0.075984	0.070335	0	
57	66000	-38.3	-36.86451	426	1	4	'0 Z 0 0 0 Z Z Z	D	6.964964	0	6.964964	6.964964	6.964964	0	0	0	0.473716	0.14118	0.385104	0	
58	67000	-36.18365	-36.85581	147	1	5	'0 Z 0 0 Z Z Z Z	D	4.571715	0	4.571715	4.571715	0	0	0	0	0.799624	0.200376	0	0	
59	68000	-36.22506	-36.84771	147	1	5	'0 Z 0 0 Z Z Z Z	D	3.634196	0	3.634196	3.634196	0	0	0	0	0.822629	0.177371	0	0	
60	69000	-37.2148	-36.87093	142	1	4	'0 Z 0 0 Z 0 Z Z	D	5.008475	0	5.008475	5.008475	0	5.008475	0	0	0.760116	0.239884	0	0	

Primates.txt.log

Remove separation symbols from the variable labels (for R)



Remove separation symbols from the data (for R)



	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Iteration	Lh	Harmonic_M	Tree_No	No_Off_Parr	No_Off_Zerc	Model_string	Dep_vs_InDe	q12	q13	q21	q24	q31	q34	q42	q43	Root_P00	Root_P01	Root_P10	Root_P11	
2	11000	-34.73239	-34.73239	117	1	2	'0 Z 0 0 0 0 0 Z	D	4.13627	0	4.13627	4.13627	4.13627	4.13627	4.13627	0	0.455361	0.236538	0.218337	0.089763	
3	12000	-34.15368	-34.48433	440	1	2	'0 Z 0 0 0 0 0 Z	D	2.886461	0	2.886461	2.886461	2.886461	2.886461	2.886461	0	0.69769	0.156703	0.128679	0.016928	
4	13000	-35.50763	-34.95065	389	1	2	'0 Z 0 0 0 0 0 Z	D	3.905301	0	3.905301	3.905301	3.905301	3.905301	3.905301	0	0.545751	0.225235	0.179373	0.04964	
5	14000	-33.70101	-34.75421	58	1	2	'0 Z 0 0 0 0 0 Z	D	3.114435	0	3.114435	3.114435	3.114435	3.114435	3.114435	0	0.747644	0.128093	0.113935	0.010328	
6	15000	-34.30844	-34.67956	208	1	2	'0 Z 0 0 0 0 0 Z	D	3.707711	0	3.707711	3.707711	3.707711	3.707711	3.707711	0	0.579118	0.210597	0.170304	0.039981	
7	16000	-33.8874	-34.58394	230	1	2	'0 Z 0 0 0 0 0 Z	D	2.630779	0	2.630779	2.630779	2.630779	2.630779	2.630779	0	0.765583	0.127661	0.097963	0.008792	
8	17000	-36.48837	-35.18086	123	1	2	'0 Z 0 0 0 0 0 Z	D	5.268185	0	5.268185	5.268185	5.268185	5.268185	5.268185	0	0.606095	0.184972	0.176083	0.03285	
9	18000	-37.257	-35.80771	275	1	5	'0 Z 0 0 Z Z Z Z	D	5.59167	0	5.59167	5.59167	0	0	0	0	0.80273	0.19727	0	0	
10	19000	-33.78404	-35.70631	43	1	3	'0 Z 0 0 0 0 Z Z	D	5.03442	0	5.03442	5.03442	5.03442	5.03442	0	0	0.695993	0.156259	0.147748	0	
11	20000	-35.99881	-35.73973	413	1	4	'0 Z 0 0 0 Z Z Z	D	5.859747	0	5.859747	5.859747	5.859747	0	0	0	0.513275	0.142872	0.343853	0	
12	21000	-35.55354	-35.72416	319	1	4	'0 Z 0 0 0 Z Z Z	D	3.548249	0	3.548249	3.548249	3.548249	0	0	0	0.759589	0.116717	0.123694	0	
13	22000	-35.90234	-35.74028	163	1	4	'0 Z 0 0 0 Z Z Z	D	5.228439	0	5.228439	5.228439	5.228439	0	0	0	0.613392	0.155599	0.231008	0	
14	23000	-33.31186	-35.66756	189	2	2	'0 Z 1 0 1 1 0 Z	D	4.241912	0	12.651573	4.241912	12.651573	12.651573	4.241912	0	0.335666	0.294873	0.244797	0.124664	
15	24000	-34.99697	-35.63204	29	1	3	'0 Z 0 0 0 0 Z Z	D	3.21398	0	3.21398	3.21398	3.21398	3.21398	0	0	0.792701	0.124846	0.082453	0	
16	25000	-37.9422	-36.10521	322	1	4	'0 Z 0 0 0 Z Z Z	D	5.13312	0	5.13312	5.13312	5.13312	0	0	0	0.624329	0.171025	0.204646	0	
17	26000	-35.5074	-36.07668	352	1	4	'0 Z 0 0 Z 0 Z Z	D	6.130502	0	6.130502	6.130502	0	6.130502	0	0	0.822448	0.177552	0	0	
18	27000	-37.00596	-36.163	144	1	3	'0 Z 0 0 0 0 Z Z	D	2.344391	0	2.344391	2.344391	2.344391	2.344391	0	0	0.799354	0.124788	0.075858	0	
19	28000	-36.39034	-36.17708	431	1	4	'0 Z 0 0 Z 0 Z Z	D	5.716214	0	5.716214	5.716214	0	5.716214	0	0	0.771422	0.228578	0	0	
20	29000	-35.55706	-36.15246	183	1	3	'0 Z 0 0 0 0 Z Z	D	6.182185	0	6.182185	6.182185	6.182185	6.182185	0	0	0.666691	0.173313	0.159995	0	
21	30000	-39.02282	-36.75796	456	1	3	'0 Z 0 Z 0 0 0 Z	D	5.139276	0	5.139276	0	5.139276	5.139276	5.139276	0	0	0	0.804402	0.195598	
22	31000	-36.49058	-36.74673	308	2	3	'1 Z 1 1 Z 1 0 Z	D	3.972622	0	3.972622	3.972622	0	3.972622	0.328558	0	0.787114	0.212447	0.000022	0.000417	
23	32000	-34.71513	-36.70643	257	1	2	'0 Z 0 0 0 0 0 Z	D	3.840032	0	3.840032	3.840032	3.840032	3.840032	3.840032	0	0.598844	0.192842	0.172089	0.036225	
24	33000	-34.4061	-36.66652	226	1	2	'0 Z 0 0 0 0 0 Z	D	3.011892	0	3.011892	3.011892	3.011892	3.011892	3.011892	0	0.740512	0.13498	0.114035	0.010473	
25	34000	-37.63029	-36.7319	226	1	3	'Z Z 0 0 0 0 0 Z	D	0	0	7.064051	7.064051	7.064051	7.064051	7.064051	0	0	0.300629	0.279982	0.419389	
26	35000	-35.43671	-36.70243	109	1	2	'0 Z 0 0 0 0 0 Z	D	2.661692	0	2.661692	2.661692	2.661692	2.661692	2.661692	0	0.747328	0.138746	0.10334	0.010586	
27	36000	-35.58605	-36.67622	379	1	2	'0 Z 0 0 0 0 0 Z	D	6.664943	0	6.664943	6.664943	6.664943	6.664943	6.664943	0	0.363826	0.253489	0.238123	0.144561	
28	37000	-36.83388	-36.68253	343	1	2	'0 Z 0 0 0 0 0 Z	D	5.086783	0	5.086783	5.086783	5.086783	5.086783	5.086783	0	0.50915	0.218903	0.213147	0.058801	
29	38000	-36.01896	-36.66505	187	1	2	'0 Z 0 0 0 0 0 Z	D	1.784534	0	1.784534	1.784534	1.784534	1.784534	1.784534	0	0.800913	0.124009	0.068864	0.006214	
30	39000	-37.35921	-36.69902	194	1	4	'0 Z 0 0 Z 0 Z Z	D	5.531088	0	5.531088	5.531088	0	5.531088	0	0	0.767335	0.232665	0	0	
31	40000	-37.47713	-36.73752	76	1	4	'0 Z 0 0 0 Z Z Z	D	5.754113	0	5.754113	5.754113	5.754113	0	0	0	0.49143	0.150288	0.358282	0	
32	41000	-35.92336	-36.71939	166	1	3	'0 Z 0 0 0 0 Z Z	D	6.313213	0	6.313213	6.313213	6.313213	6.313213	0	0	0.665446	0.174521	0.160033	0	
33	42000	-34.65024	-36.6917	257	1	2	'0 Z 0 0 0 0 0 Z	D	3.593436	0	3.593436	3.593436	3.593436	3.593436	3.593436	0	0.620005	0.18671	0.161902	0.031383	
34	43000	-35.41928	-36.66965	111	1	2	'0 Z 0 0 0 0 0 Z	D	3.783198	0	3.783198	3.783198	3.783198	3.783198	3.783198	0	0.60751	0.187019	0.172493	0.032978	
35	44000	-38.4884	-36.81105	446	1	4	'0 Z 0 0 0 Z Z Z	D	4.054294	0	4.054294	4.054294	4.054294	0	0	0	0.630012	0.153422	0.216566	0	
36	45000	-36.77277	-36.80998	307	1	4	'0 Z 0 0 Z 0 Z Z	D	4.689772	0	4.689772	4.689772	0	4.689772	0	0	0.81672	0.18328	0	0	
37	46000	-34.45016	-36.7845	307	1	2	'0 Z 0 0 0 0 0 Z	D	4.16759	0	4.16759	4.16759	4.16759	4.16759	4.16759	0	0.577596	0.196785	0.184794	0.040826	
38	47000	-38.22571	-36.86809	322	1	4	'0 Z 0 0 0 Z Z Z	D	3.568456	0	3.568456	3.568456	3.568456	0	0	0	0.717164	0.171924	0.110912	0	
39	48000	-38.21997	-36.94077	307	1	3	'0 Z 0 0 0 0 Z Z	D	7.150521	0	7.150521	7.150521	7.150521	7.150521	0	0	0.632563	0.185938	0.181499	0	
40	49000	-36.61836	-36.93368	286	1	2	'0 Z 0 0 0 0 0 Z	D	5.320292	0	5.320292	5.320292	5.320292	5.320292	5.320292	0	0.509146	0.216393	0.210619	0.063841	
41	50000	-34.79274	-36.91137	479	1	2	'0 Z 0 0 0 0 0 Z	D	3.58442	0	3.58442	3.58442	3.58442	3.58442	3.58442	0	0.664121	0.173847	0.139913	0.022119	
42	51000	-35.085	-36.89069	232	1	4	'0 Z 0 0 0 Z Z Z	D	4.336146	0	4.336146	4.336146	4.336146	0	0	0	0.660982	0.134312	0.204706	0	
43	52000	-37.91837	-36.93253	267	1	4	'0 Z 0 0 0 Z Z Z	D	9.032466	0	9.032466	9.032466	9.032466	0	0	0	0.401439	0.125405	0.473156	0	
44	53000	-35.81236	-36.91674	380	1	2	'0 Z 0 0 0 0 0 Z	D	4.087888	0	4.087888	4.087888	4.087888	4.087888	4.087888	0	0.512945	0.235443	0.188735	0.062877	
45	54000	-37.96993	-36.95829	198	2	3	'1 Z 1 0 Z Z 1 0	D	2.169529	0	2.169529	2.127246	0	0	2.169529	2.127246	0.889453	0.10814	0	0.002407	
46	55000	-34.18833	-36.93724	198	1	2	'0 Z 0 0 0 0 0 Z	D	3.984127	0	3.984127	3.984127	3.984127	3.984127	3.984127	0	0.644946	0.174232	0.159636	0.021187	
47	56000	-36.42277	-36.92846	82	1	2	'0 Z 0 0 0 0 0 Z	D	4.762162	0	4.762162	4.762162	4.762162	4.762162	4.762162	0	0.49422	0.226047	0.210683	0.069051	
48	57000	-35.10888	-36.91047	120	1	2	'0 Z 0 0 0 0 0 Z	D	4.135661	0	4.135661	4.135661	4.135661	4.135661	4.135661	0	0.660704	0.171929	0.143921	0.023446	
49	58000	-34.46116	-36.89125	451	1	2	'0 Z 0 0 0 0 0 Z	D	4.389025	0	4.389025	4.389025	4.389025	4.389025	4.389025	0	0.57882	0.207333	0.170814	0.043032	
50	59000	-35.95205	-36.87875	218	1	4	'0 Z 0 0 0 Z Z Z	D	3.870718	0	3.870718	3.870718	3.870718	0	0	0	0.672618	0.1532	0.174183	0	
51	60000	-33.74976	-36.85944	201	1	2	'0 Z 0 0 0 0 0 Z	D	2.84584	0	2.84584	2.84584	2.84584	2.84584	2.84584	0	0.74952	0.129997	0.110065	0.010418	
52	61000	-35.42123	-36.84437	451	1	4	'0 Z 0 0 0 Z Z Z	D	3.975406	0	3.975406	3.975406	3.975406	0	0	0	0.701816	0.140408	0.157776	0	
53	62000	-35.30645	-36.82916	2	1	5	'0 Z 0 0 Z Z Z Z	D	4.875197	0	4.875197	4.875197	0	0	0	0	0.790567	0.209433	0	0	
54	63000	-36.21767	-36.82049	180	1	4	'0 Z 0 0 Z 0 Z Z	D	5.261476	0	5.261476	5.261476	0	5.261476	0	0	0.80312	0.19688	0	0	
55	64000	-36.00645	-36.81012	83	1	5	'0 Z 0 0 Z Z Z Z	D	2.772881	0	2.772881	2.772881	0	0	0	0	0.864472	0.135528	0	0	
56	65000	-36.44437	-36.80453	481	1	4	'0 Z 0 0 0 Z Z Z	D	2.534726	0	2.534726	2.534726	2.534726	0	0	0	0.853681	0.075984	0.070335	0	
57	66000	-38.3	-36.86451	426	1	4	'0 Z 0 0 0 Z Z Z	D	6.964964	0	6.964964	6.964964	6.964964	0	0	0	0.473716	0.14118	0.385104	0	
58	67000	-36.18365	-36.85581	147	1	5	'0 Z 0 0 Z Z Z Z	D	4.571715	0	4.571715	4.571715	0	0	0	0	0.799624	0.200376	0	0	
59	68000	-36.22506	-36.84771	147	1	5	'0 Z 0 0 Z Z Z Z	D	3.634196	0	3.634196	3.634196	0	0	0	0	0.822629	0.177371	0	0	
60	69000	-37.7149	-36.87088	142	1	4	'0 Z 0 0 Z 0 Z Z	D	5.008475	0	5.008475	5.008475	0	5.008475	0	0	0.769116	0.230884	0	0	

Remove separation symbols from the data (for R)

Primates_exp10_RJMCMC.txt

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	Iteration	Lh	Harmonic_M	Tree_No	No_Off_Par	No_Off_Zerc	Model_string	Dep_vs_InDe	q12	q13	q21	q24	q31	q34	q42	q43	Root_P00	Root_P01	Root_P10	Root_P11	
2	11000	-34.73239	-34.73239	117	1	2	0Z00000Z	D	4.13627	0	4.13627	4.13627	4.13627	4.13627	4.13627	0	0.455361	0.236538	0.218337	0.089763	
3	12000	-34.15368	-34.48433	440	1	2	0Z00000Z	D	2.886461	0	2.886461	2.886461	2.886461	2.886461	2.886461	0	0.69769	0.156703	0.128679	0.016928	
4	13000	-35.50763	-34.95065	389	1	2	0Z00000Z	D	3.905301	0	3.905301	3.905301	3.905301	3.905301	3.905301	0	0.545751	0.225235	0.179373	0.04964	
5	14000	-33.70101	-34.75421	58	1	2	0Z00000Z	D	3.114435	0	3.114435	3.114435	3.114435	3.114435	3.114435	0	0.747644	0.128093	0.113935	0.010328	
6	15000	-34.30844	-34.67956	208	1	2	0Z00000Z	D	3.707711	0	3.707711	3.707711	3.707711	3.707711	3.707711	0	0.579118	0.210597	0.170304	0.039981	
7	16000	-33.8874	-34.58394	230	1	2	0Z00000Z	D	2.630779	0	2.630779	2.630779	2.630779	2.630779	2.630779	0	0.765583	0.127661	0.097963	0.008792	
8	17000	-36.48837	-35.18086	123	1	2	0Z00000Z	D	5.268185	0	5.268185	5.268185	5.268185	5.268185	5.268185	0	0.606095	0.184972	0.176083	0.03285	
9	18000	-37.257	-35.80771	275	1	5	0Z00ZZZZ	D	5.59167	0	5.59167	5.59167	0	0	0	0	0.80273	0.19727	0	0	
10	19000	-33.78404	-35.70631	43	1	3	0Z0000ZZ	D	5.03442	0	5.03442	5.03442	5.03442	5.03442	0	0	0.695993	0.156259	0.147748	0	
11	20000	-35.99881	-35.73973	413	1	4	0Z000ZZZ	D	5.859747	0	5.859747	5.859747	5.859747	0	0	0	0.513275	0.142872	0.343853	0	
12	21000	-35.55354	-35.72416	319	1	4	0Z000ZZZ	D	3.548249	0	3.548249	3.548249	3.548249	0	0	0	0.759589	0.116717	0.123694	0	
13	22000	-35.90234	-35.74028	163	1	4	0Z000ZZZ	D	5.228439	0	5.228439	5.228439	5.228439	0	0	0	0.613392	0.155599	0.231008	0	
14	23000	-33.31186	-35.66756	189	2	2	0Z10110Z	D	4.241912	0	12.651573	4.241912	12.651573	12.651573	4.241912	0	0.335666	0.294873	0.244797	0.124664	
15	24000	-34.99697	-35.63204	29	1	3	0Z0000ZZ	D	3.21398	0	3.21398	3.21398	3.21398	3.21398	0	0	0.792701	0.124846	0.082453	0	
16	25000	-37.9422	-36.10521	322	1	4	0Z000ZZZ	D	5.13312	0	5.13312	5.13312	5.13312	0	0	0	0.624329	0.171025	0.204646	0	
17	26000	-35.5074	-36.07668	352	1	4	0Z00Z0ZZ	D	6.130502	0	6.130502	6.130502	0	6.130502	0	0	0.822448	0.177552	0	0	
18	27000	-37.00596	-36.163	144	1	3	0Z0000ZZ	D	2.344391	0	2.344391	2.344391	2.344391	2.344391	0	0	0.799354	0.124788	0.075858	0	
19	28000	-36.39034	-36.17708	431	1	4	0Z00Z0ZZ	D	5.716214	0	5.716214	5.716214	0	5.716214	0	0	0.771422	0.228578	0	0	
20	29000	-35.55706	-36.15246	183	1	3	0Z0000ZZ	D	6.182185	0	6.182185	6.182185	6.182185	6.182185	0	0	0.666691	0.173313	0.159995	0	
21	30000	-39.02282	-36.75796	456	1	3	0Z0Z000Z	D	5.139276	0	5.139276	0	5.139276	5.139276	5.139276	0	0	0	0.804402	0.195598	
22	31000	-36.49058	-36.74673	308	2	3	1Z11Z10Z	D	3.972622	0	3.972622	3.972622	0	3.972622	0.328558	0	0.787114	0.212447	0.000022	0.000417	
23	32000	-34.71513	-36.70643	257	1	2	0Z00000Z	D	3.840032	0	3.840032	3.840032	3.840032	3.840032	3.840032	0	0.598844	0.192842	0.172089	0.036225	
24	33000	-34.4061	-36.66652	226	1	2	0Z00000Z	D	3.011892	0	3.011892	3.011892	3.011892	3.011892	3.011892	0	0.740512	0.13498	0.114035	0.010473	
25	34000	-37.63029	-36.7319	226	1	3	ZZ00000Z	D	0	0	7.064051	7.064051	7.064051	7.064051	7.064051	0	0	0.300629	0.279982	0.419389	
26	35000	-35.43671	-36.70243	109	1	2	0Z00000Z	D	2.661692	0	2.661692	2.661692	2.661692	2.661692	2.661692	0	0.747328	0.138746	0.10334	0.010586	
27	36000	-35.58605	-36.67622	379	1	2	0Z00000Z	D	6.664943	0	6.664943	6.664943	6.664943	6.664943	6.664943	0	0.363826	0.253489	0.238123	0.144561	
28	37000	-36.83388	-36.68253	343	1	2	0Z00000Z	D	5.086783	0	5.086783	5.086783	5.086783	5.086783	5.086783	0	0.50915	0.218903	0.213147	0.058801	
29	38000	-36.01896	-36.66505	187	1	2	0Z00000Z	D	1.784534	0	1.784534	1.784534	1.784534	1.784534	1.784534	0	0.800913	0.124009	0.068864	0.006214	
30	39000	-37.35921	-36.69902	194	1	4	0Z00Z0ZZ	D	5.531088	0	5.531088	5.531088	0	5.531088	0	0	0.767335	0.232665	0	0	
31	40000	-37.47713	-36.73752	76	1	4	0Z000ZZZ	D	5.754113	0	5.754113	5.754113	5.754113	0	0	0	0.49143	0.150288	0.358282	0	
32	41000	-35.92336	-36.71939	166	1	3	0Z0000ZZ	D	6.313213	0	6.313213	6.313213	6.313213	6.313213	0	0	0.665446	0.174521	0.160033	0	
33	42000	-34.65024	-36.6917	257	1	2	0Z00000Z	D	3.593436	0	3.593436	3.593436	3.593436	3.593436	3.593436	0	0.620005	0.18671	0.161902	0.031383	
34	43000	-35.41928	-36.66965	111	1	2	0Z00000Z	D	3.783198	0	3.783198	3.783198	3.783198	3.783198	3.783198	0	0.60751	0.187019	0.172493	0.032978	
35	44000	-38.4884	-36.81105	446	1	4	0Z000ZZZ	D	4.054294	0	4.054294	4.054294	4.054294	0	0	0	0.630012	0.153422	0.216566	0	
36	45000	-36.77277	-36.80998	307	1	4	0Z00Z0ZZ	D	4.689772	0	4.689772	4.689772	0	4.689772	0	0	0.81672	0.18328	0	0	
37	46000	-34.45016	-36.7845	307	1	2	0Z00000Z	D	4.16759	0	4.16759	4.16759	4.16759	4.16759	4.16759	0	0.577596	0.196785	0.184794	0.040826	
38	47000	-38.22571	-36.86809	322	1	4	0Z000ZZZ	D	3.568456	0	3.568456	3.568456	3.568456	0	0	0	0.717164	0.171924	0.110912	0	
39	48000	-38.21997	-36.94077	307	1	3	0Z0000ZZ	D	7.150521	0	7.150521	7.150521	7.150521	7.150521	0	0	0.632563	0.185938	0.181499	0	
40	49000	-36.61836	-36.93368	286	1	2	0Z00000Z	D	5.320292	0	5.320292	5.320292	5.320292	5.320292	5.320292	0	0.509146	0.216393	0.210619	0.063841	
41	50000	-34.79274	-36.91137	479	1	2	0Z00000Z	D	3.58442	0	3.58442	3.58442	3.58442	3.58442	3.58442	0	0.664121	0.173847	0.139913	0.022119	
42	51000	-35.085	-36.89069	232	1	4	0Z000ZZZ	D	4.336146	0	4.336146	4.336146	4.336146	0	0	0	0.660982	0.134312	0.204706	0	
43	52000	-37.91837	-36.93253	267	1	4	0Z000ZZZ	D	9.032466	0	9.032466	9.032466	9.032466	0	0	0	0.401439	0.125405	0.473156	0	
44	53000	-35.81236	-36.91674	380	1	2	0Z00000Z	D	4.087888	0	4.087888	4.087888	4.087888	4.087888	4.087888	0	0.512945	0.235443	0.188735	0.062877	
45	54000	-37.96993	-36.95829	198	2	3	1Z10ZZ10	D	2.169529	0	2.169529	2.127246	0	0	2.169529	2.127246	0.889453	0.10814	0	0.002407	
46	55000	-34.18833	-36.93724	198	1	2	0Z00000Z	D	3.984127	0	3.984127	3.984127	3.984127	3.984127	3.984127	0	0.644946	0.174232	0.159636	0.021187	
47	56000	-36.42277	-36.92846	82	1	2	0Z00000Z	D	4.762162	0	4.762162	4.762162	4.762162	4.762162	4.762162	0	0.49422	0.226047	0.210683	0.069051	
48	57000	-35.10888	-36.91047	120	1	2	0Z00000Z	D	4.135661	0	4.135661	4.135661	4.135661	4.135661	4.135661	0	0.660704	0.171929	0.143921	0.023446	
49	58000	-34.46116	-36.89125	451	1	2	0Z00000Z	D	4.389025	0	4.389025	4.389025	4.389025	4.389025	4.389025	0	0.57882	0.207333	0.170814	0.043032	
50	59000	-35.95205	-36.87875	218	1	4	0Z000ZZZ	D	3.870718	0	3.870718	3.870718	3.870718	0	0	0	0.672618	0.1532	0.174183	0	
51	60000	-33.74976	-36.85944	201	1	2	0Z00000Z	D	2.84584	0	2.84584	2.84584	2.84584	2.84584	2.84584	0	0.74952	0.129997	0.110065	0.010418	
52	61000	-35.42123	-36.84437	451	1	4	0Z000ZZZ	D	3.975406	0	3.975406	3.975406	3.975406	0	0	0	0.701816	0.140408	0.157776	0	
53	62000	-35.30645	-36.82916	2	1	5	0Z00ZZZZ	D	4.875197	0	4.875197	4.875197	0	0	0	0	0.790567	0.209433	0	0	
54	63000	-36.21767	-36.82049	180	1	4	0Z00Z0ZZ	D	5.261476	0	5.261476	5.261476	0	5.261476	0	0	0.80312	0.19688	0	0	
55	64000	-36.00645	-36.81012	83	1	5	0Z00ZZZZ	D	2.772881	0	2.772881	2.772881	0	0	0	0	0.864472	0.135528	0	0	
56	65000	-36.44437	-36.80453	481	1	4	0Z000ZZZ	D	2.534726	0	2.534726	2.534726	2.534726	0	0	0	0.853681	0.075984	0.070335	0	
57	66000	-38.3	-36.86451	426	1	4	0Z000ZZZ	D	6.964964	0	6.964964	6.964964	6.964964	0	0	0	0.473716	0.14118	0.385104	0	
58	67000	-36.18365	-36.85581	147	1	5	0Z00ZZZZ	D	4.571715	0	4.571715	4.571715	0	0	0	0	0.799624	0.200376	0	0	
59	68000	-36.22506	-36.84771	147	1	5	0Z00ZZZZ	D	3.634196	0	3.634196	3.634196	0	0	0	0	0.822629	0.177371	0	0	
60	69000	-37.7148	-36.87089	142	1	4	0Z00Z0ZZ	D	5.008475	0	5.008475	5.008475	0	5.008475	0	0	0.769116	0.230884	0	0	

Primates_exp10_RJMCMC

Save as “Primates_exp10_RJMCMC.txt”.

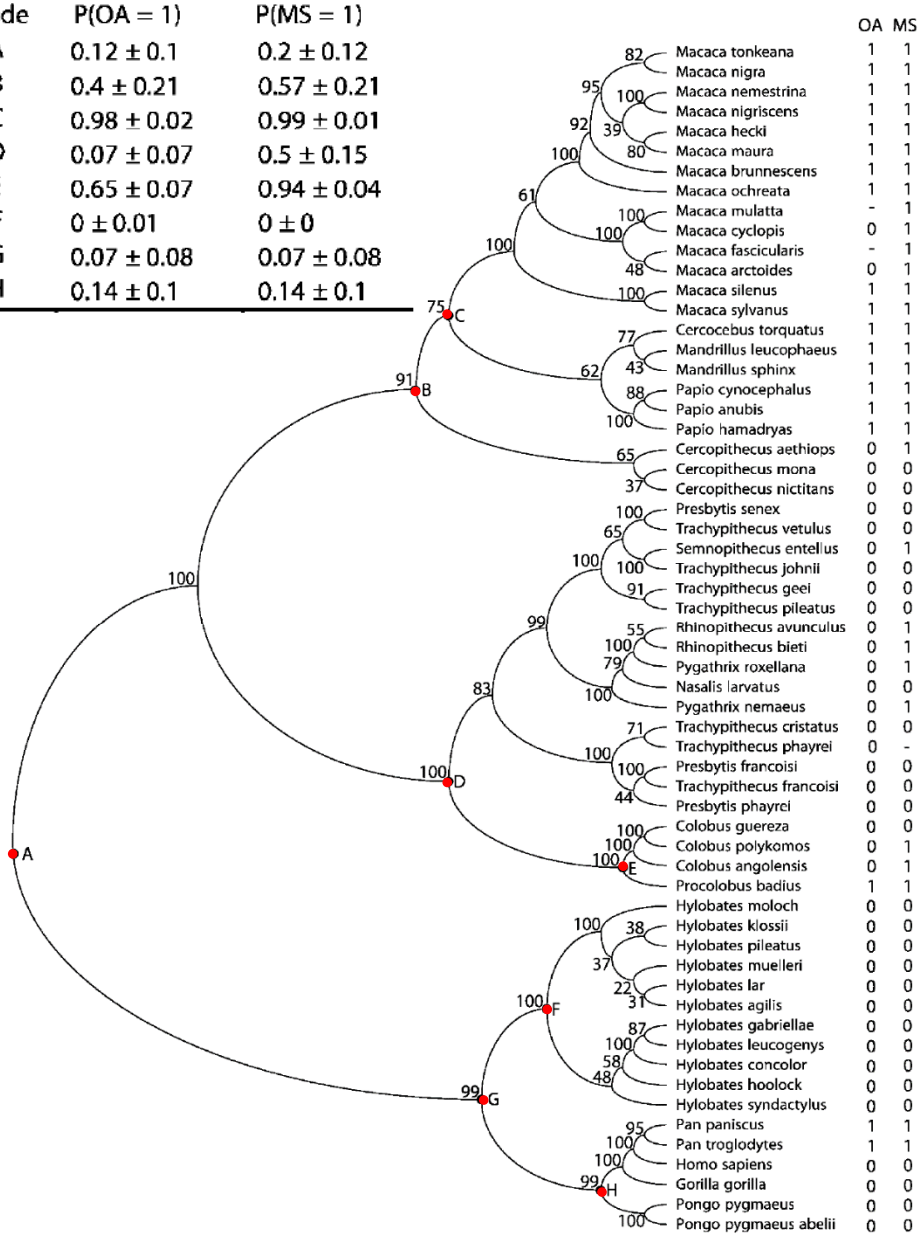
Read Primates_exp10_RJMCMC.txt by R

```
read.table("Primates_exp10_RJMCMC.txt",header=T)->data0
names(data0)
```

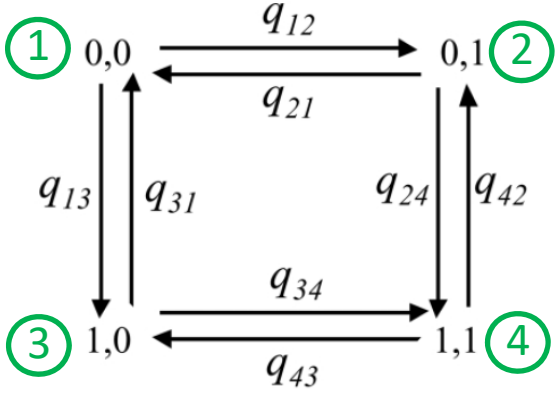
```
 [1] "Iteration"        "Lh"               "Harmonic_Mean"    "Tree_No"
 [5] "No_Off_Parmeters" "No_Off_Zero"      "Model_string"     "Dep_vs_InDep"
 [9] "q12"              "q13"              "q21"              "q24"
[13] "q31"              "q34"              "q42"              "q43"
[17] "Root_P00"         "Root_P01"         "Root_P10"         "Root_P11"
```

Estrus advertisement and multimale system

Node	P(OA = 1)	P(MS = 1)
A	0.12 ± 0.1	0.2 ± 0.12
B	0.4 ± 0.21	0.57 ± 0.21
C	0.98 ± 0.02	0.99 ± 0.01
D	0.07 ± 0.07	0.5 ± 0.15
E	0.65 ± 0.07	0.94 ± 0.04
F	0 ± 0.01	0 ± 0
G	0.07 ± 0.08	0.07 ± 0.08
H	0.14 ± 0.1	0.14 ± 0.1



OA: estrus advertisement
MS: multimale system



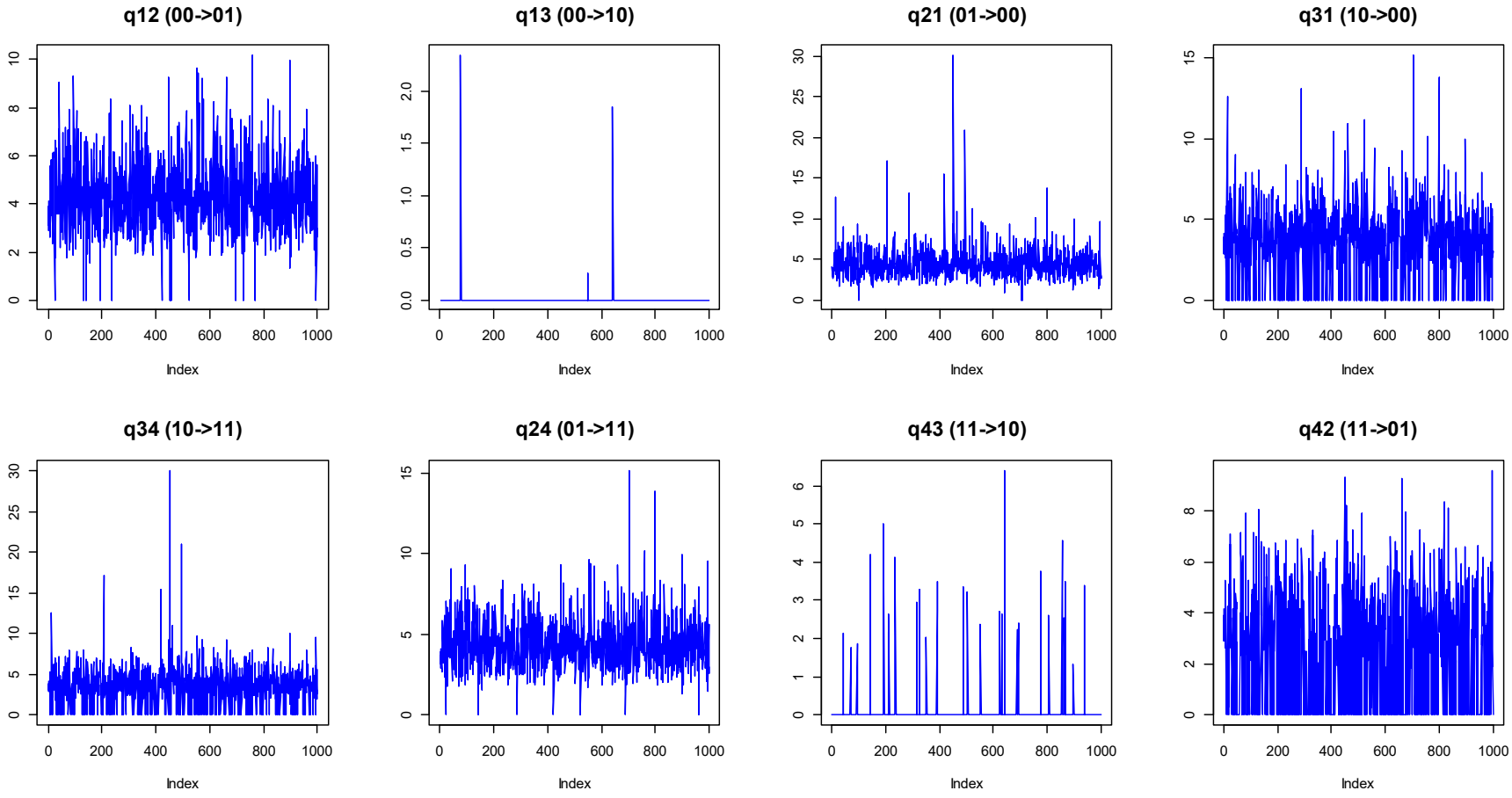
If OA and MS are independent,

$$q_{12} = q_{34}, q_{13} = q_{24}, q_{21} = q_{43}, q_{31} = q_{42}$$

Pagel and Meade. (2006) the American Naturalist **167:** 808–825

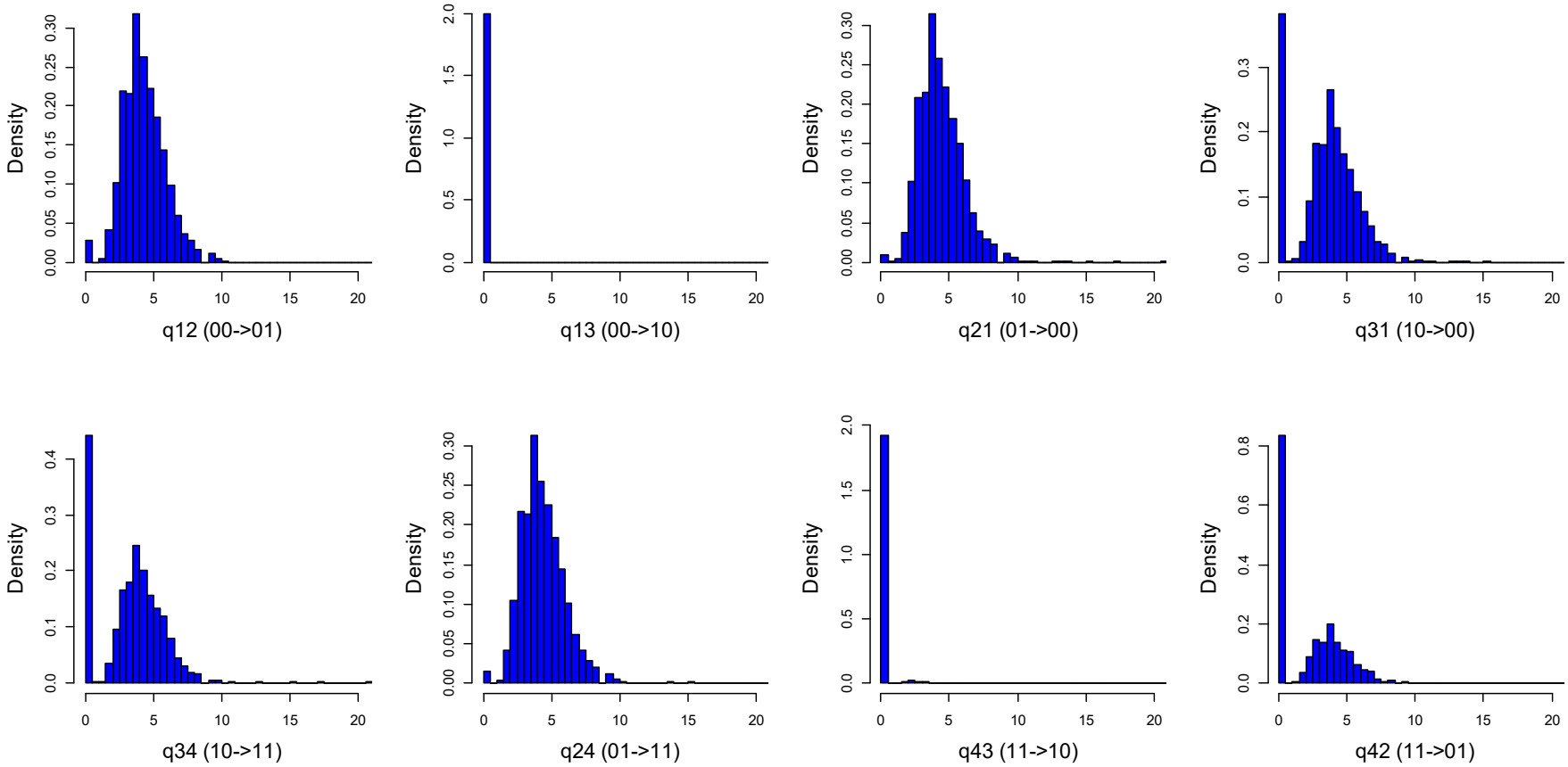
Plot the MCMC sample of q_{ij}

```
par(mfcol=c(2,4))
for (i in para_set){
   plot(data0[,i],type="l",main=names(data0)[i],ylab="",col=4)
}
par(mfcol=c(1,1))
```



The posterior distribution of q_{ij}

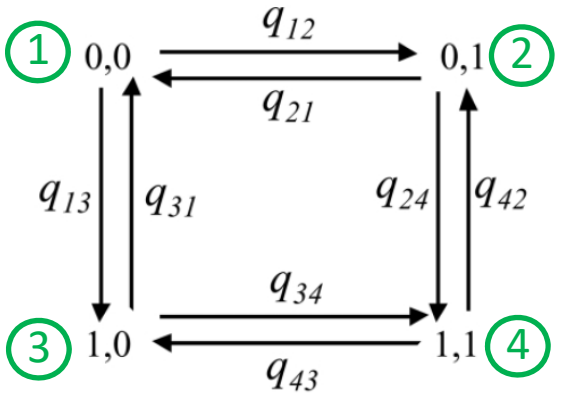
```
par(mfcol=c(2,4))
for (i in para_set){
   hist(data0[,i],main="",xlab=names(data0)[i],col=4,
        breaks=seq(0,100,by=0.5),probability=T,xlim=c(0,20))
}
par(mfcol=c(1,1))
```



The posterior distribution of q_{ij} : summary statistics

```
summary(data0[,para_set])
```

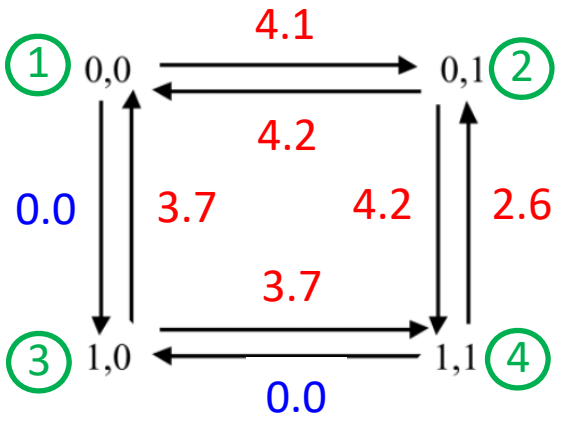
```
q12                q34                q13                 q24                q21
Min.   : 0.000   Min.   : 0.000   Min.   :0.000000   Min.   : 0.000   Min.   : 0.000
1st Qu.: 3.239   1st Qu.: 2.084   1st Qu.:0.000000   1st Qu.: 3.268   1st Qu.: 3.342
Median : 4.133   Median : 3.667   Median :0.000000   Median : 4.154   Median : 4.204
Mean   : 4.287   Mean   : 3.439   Mean   :0.004451   Mean   : 4.363   Mean   : 4.481
3rd Qu.: 5.228   3rd Qu.: 4.827   3rd Qu.:0.000000   3rd Qu.: 5.279   3rd Qu.: 5.343
Max.   :10.179   Max.   :30.099   Max.   :2.344290   Max.   :15.186   Max.   :30.099
     q43                q31                q42
Min.   :0.0000   Min.   : 0.000   Min.   :0.000
1st Qu.:0.0000   1st Qu.: 2.443   1st Qu.:0.000
Median :0.0000   Median : 3.745   Median :2.587
Mean   :0.1022   Mean   : 3.554   Mean   :2.386
3rd Qu.:0.0000   3rd Qu.: 4.930   3rd Qu.:4.136
Max.   :6.4084   Max.   :15.186   Max.   :9.586
```



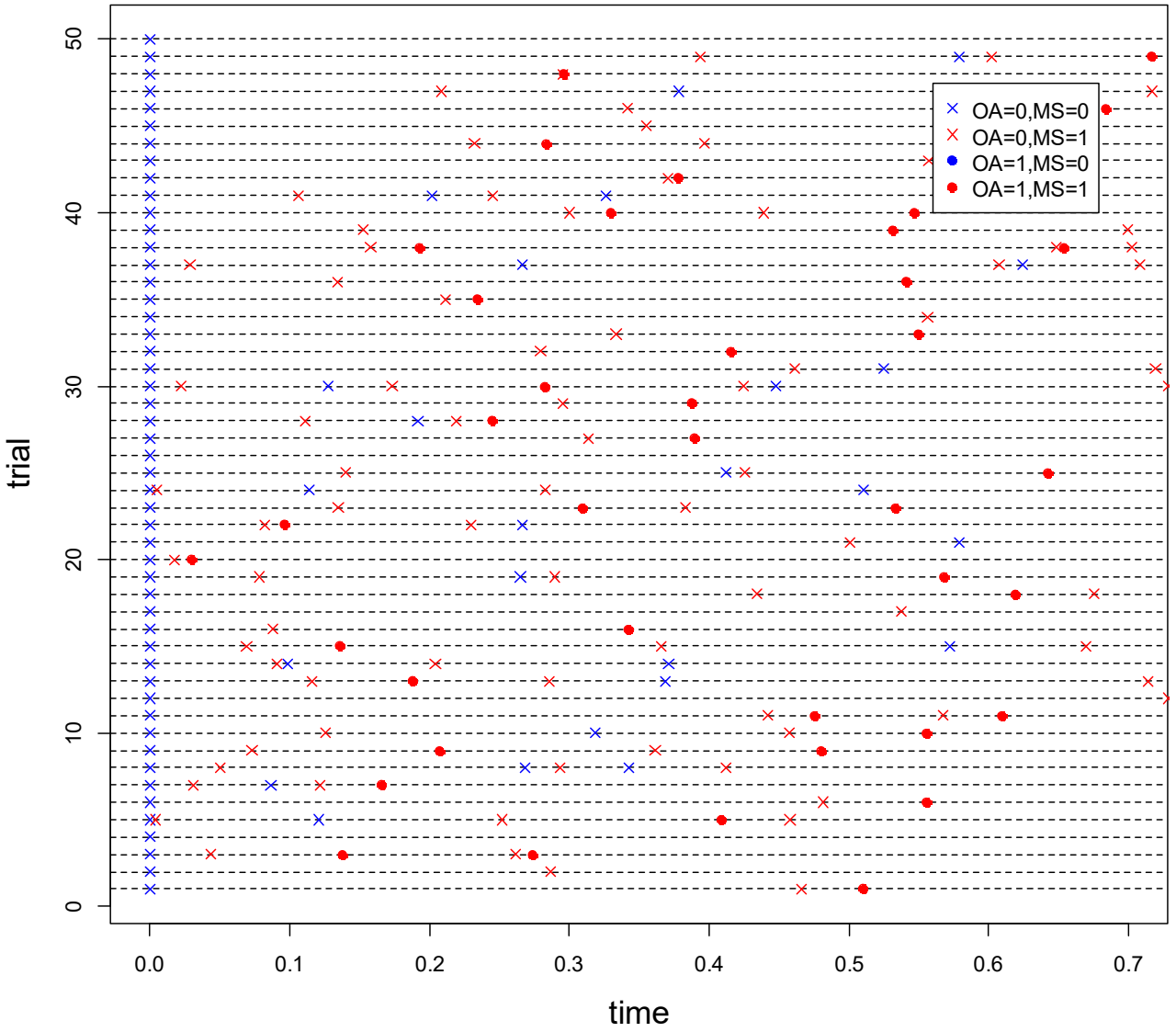
The posterior distribution of q_{ij} : summary statistics

```
summary(data0[,para_set])
```

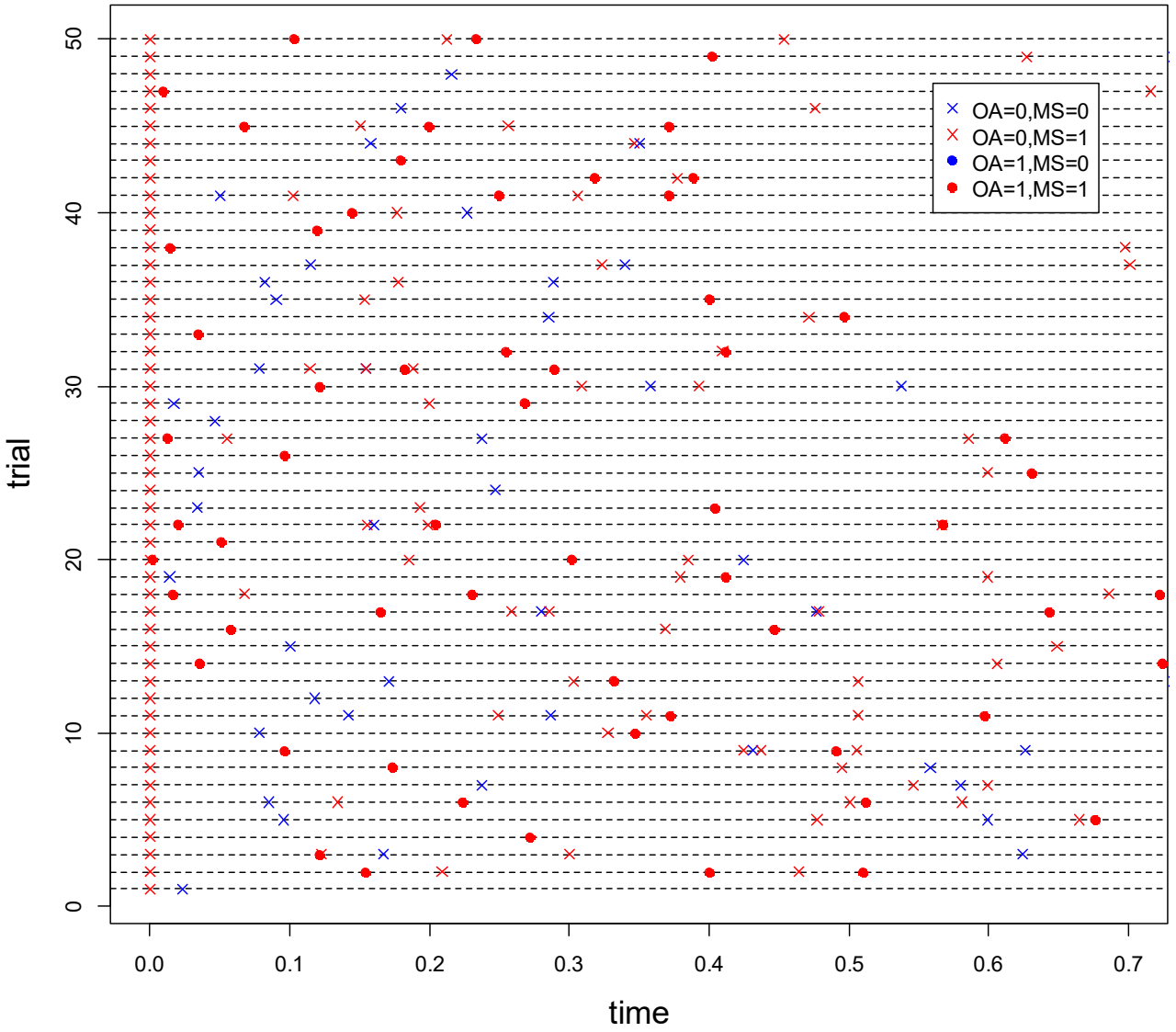
```
q12                q34                q13                 q24                q21
Min.   : 0.000   Min.   : 0.000   Min.   :0.000000   Min.   : 0.000   Min.   : 0.000
1st Qu.: 3.239   1st Qu.: 2.084   1st Qu.:0.000000   1st Qu.: 3.268   1st Qu.: 3.342
Median : 4.133   Median : 3.667   Median :0.000000   Median : 4.154   Median : 4.204
Mean   : 4.287   Mean   : 3.439   Mean   :0.004451   Mean   : 4.363   Mean   : 4.481
3rd Qu.: 5.228   3rd Qu.: 4.827   3rd Qu.:0.000000   3rd Qu.: 5.279   3rd Qu.: 5.343
Max.   :10.179   Max.   :30.099   Max.   :2.344290   Max.   :15.186   Max.   :30.099
     q43                q31                q42
Min.   :0.0000   Min.   : 0.000   Min.   :0.000
1st Qu.:0.0000   1st Qu.: 2.443   1st Qu.:0.000
Median :0.0000   Median : 3.745   Median :2.587
Mean   :0.1022   Mean   : 3.554   Mean   :2.386
3rd Qu.:0.0000   3rd Qu.: 4.930   3rd Qu.:4.136
Max.   :6.4084   Max.   :15.186   Max.   :9.586
```



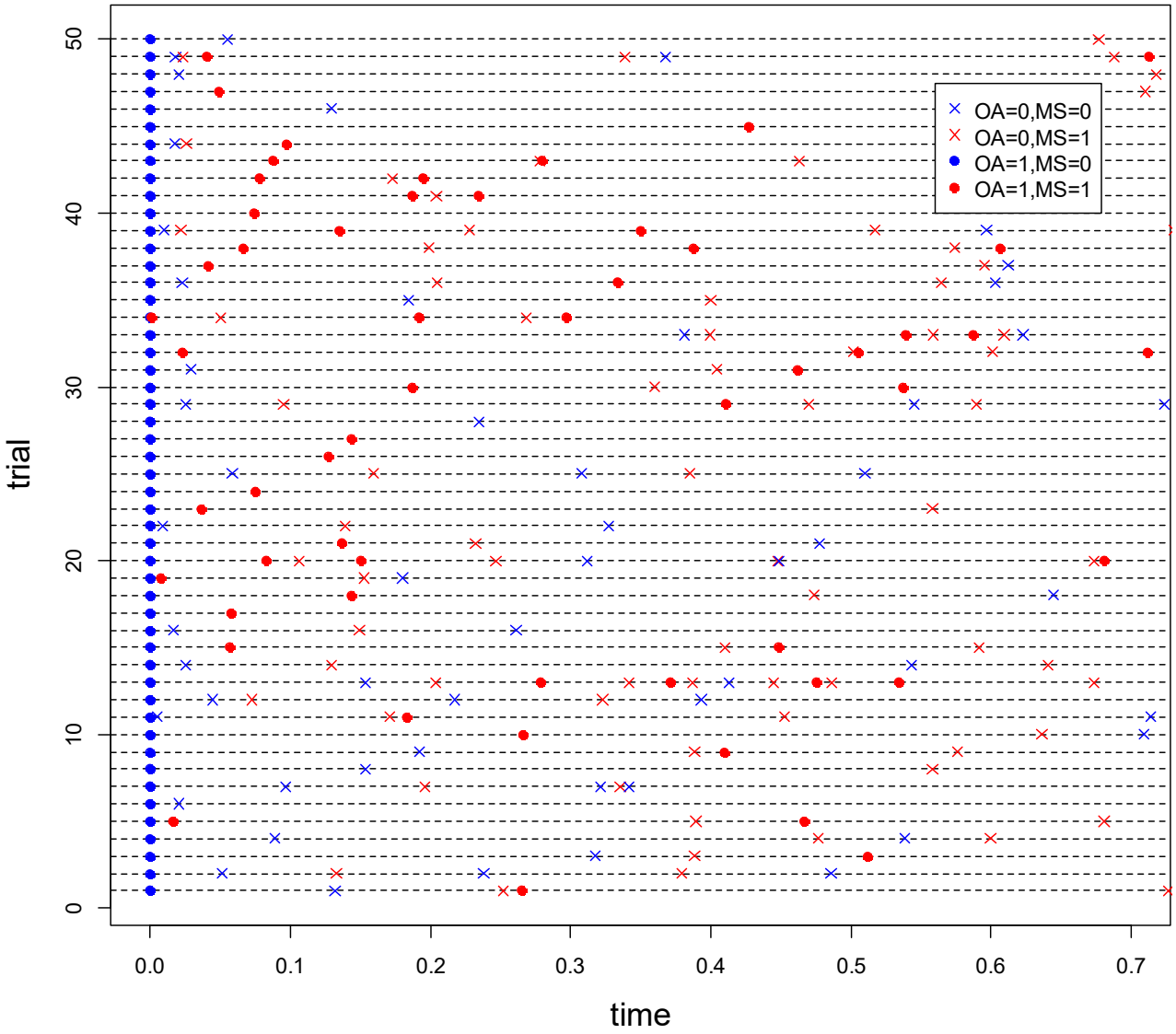
Simulating sample paths starting with the state (OA=0,MS=0)



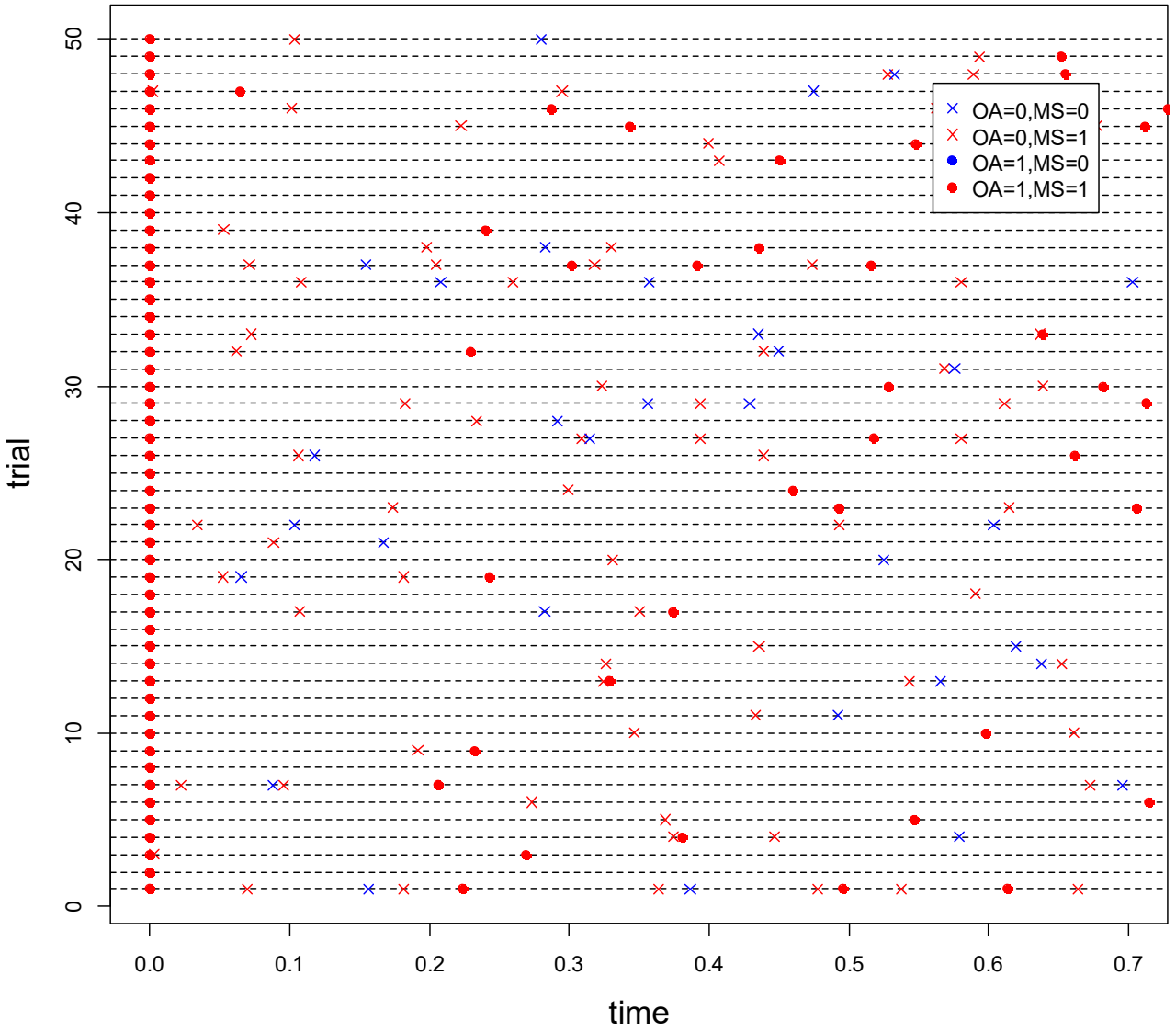
Simulating sample paths starting with the state (OA=0,MS=1)



Simulating sample paths starting with the state (OA=1,MS=0)



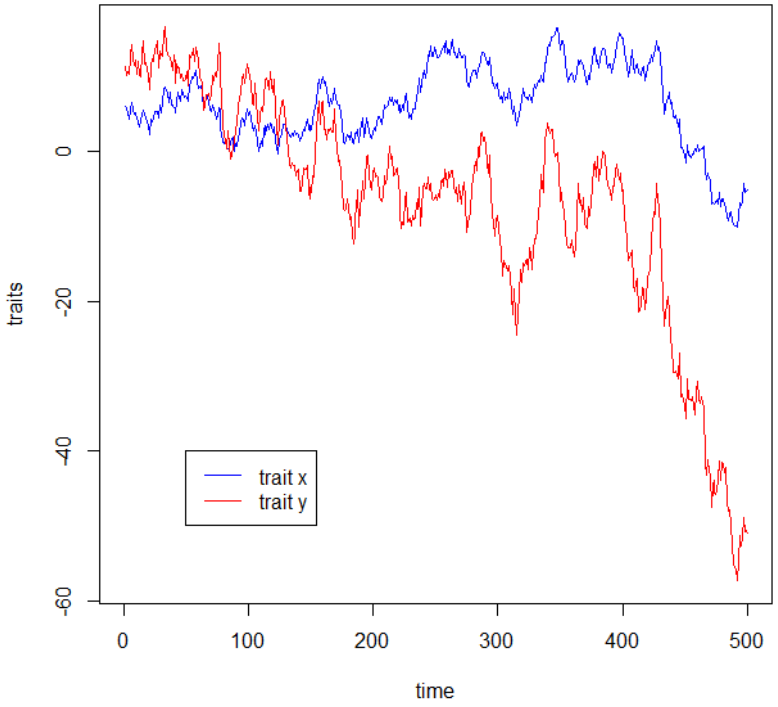
Simulating sample paths starting with the state (OA=1,MS=1)



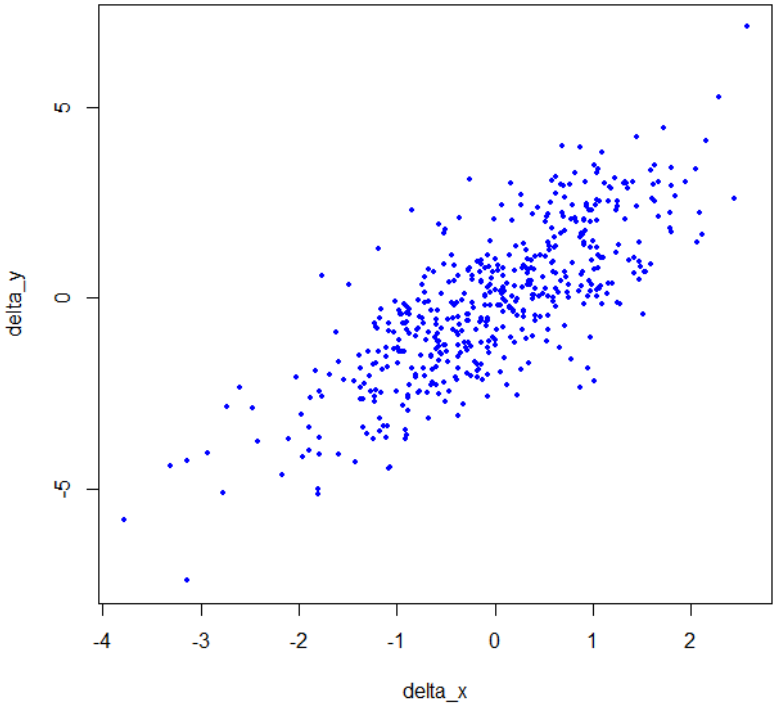
Analysis of continuous traits by Beast

Multivariate Brownian motion as a model of evolution of continuous traits

Evolution of two continuous traits



Correlation between rates of change



DNA sequences (nexus format)

```
#NEXUS

[ Cytb + Control region for 13 species of Darwin's Finches ]
[ from Sato et al (1999) PNAS 96, 5101–5106            ]
Begin DATA;
                Dimensions ntax=13 nchar=2065;
                Format datatype=NUCLEOTIDE gap=-;
                Matrix
                [            1    11    21    31    41    51    61    71    81    91    101   111   121   131   141   151
161   171   181   191   201   211   221   231   241   251   261   271   281   291   301   311   321   331   341   351
361   371   381   391   401   411   421   431   441   451   461   471   481   491   501   511   521   531   541   551
                                          . . . . . . . . . . . . . . . .
2041       2051       2061      ]
                [           |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
                                          . . . . . . . . . . . . . . . .
|    |    |    |    |    |    |    |    |    |    |    |    |    |    |  ]
                'Cactospiza pallida '
GGATCCCTGTTAGGAGTTTGCTTAATCACTCAAATCATCACAGGTCTCCTTCTAGCCATACACTACACAGCAGACACCAACCTAGCCTTCTCCTCCGTCGCCCACATATGC
CGAGACGTCCAATTCGGCTGACTCATCCGCAACCTCCACGCAAACGGAGCCTCCTTCTTCTTCATCTGCATCTACCTACACATCGGACGAGG-AATCTACTACGGCTCATA
CCTAAATAAAGAAACCTGAAACATTGGAGTCATCCTCCTCCTAGCCCTCATAGCAACAGCCTTTGTAGGATACGTCCTACCATGAGGCCAAATATCCTTCTGAGGAGCTA
                                          . . . . . . . . . . . . . . . .
TACATTTCCTGCTAACATAAAACAACAACTAACCATCATCACCACCATATT-TTTTCCCCCCCC-CT-TTCCCCCACCCCACACAAAACAGCCCTTACAAAAACCAAA-CAAA
AATACAAACCATGACACCAAA-CCACTAAAGG-AA--CCCCCTCTC-GTTCTTGTAGCTTATAAAAAGCATGACACT
                'Platyspiza crassirostris '
GGATCCCTGTTAGGAGTTTGCTTAATCACCCAAATCATCACAGGTCTCCTTCTAGCCATGCACTACACAGCAGACACCGACCTAGCCTTCTCCTCCGTCGCCCACATATGC
CGAGACGTCCAATTCGGCTGACTCATCCGCAACCTTCACGCAAACGGAGCCTCTTTCTTCTTCATCTGCATCTACCTACACATCGGACGAGG-AATCTACTACGGCTCATA
                                          . . . . . . . . . . . . . . . .
ATCAAATTCTAGGAACTTACATTTAAATTCCATTTTACGCATCTATTTTTTTTATCTTGACATTTTTAAAATTTTTTCATCAAATAATCAAACCATATATTCCTAGATTGTCCA
AACTATTTGTCATCAACATTT-CCAACTTACTTTCCTCTATATTTCCTGCTAACATAAAACAACAACTAACTATCATCACCACCACATT-TTT--CCTCCCCTTT-TTCCCCNACC
CCACATAAAACAGCCCTTACAAAAACCAAA-CAAAAATATAAACCATGACACCAAA-CCACTAAGGG-AA-CCCCCC-CCC-GTTCTTGTAGCTTATAGAAAGCATGACACT
;
End;
```

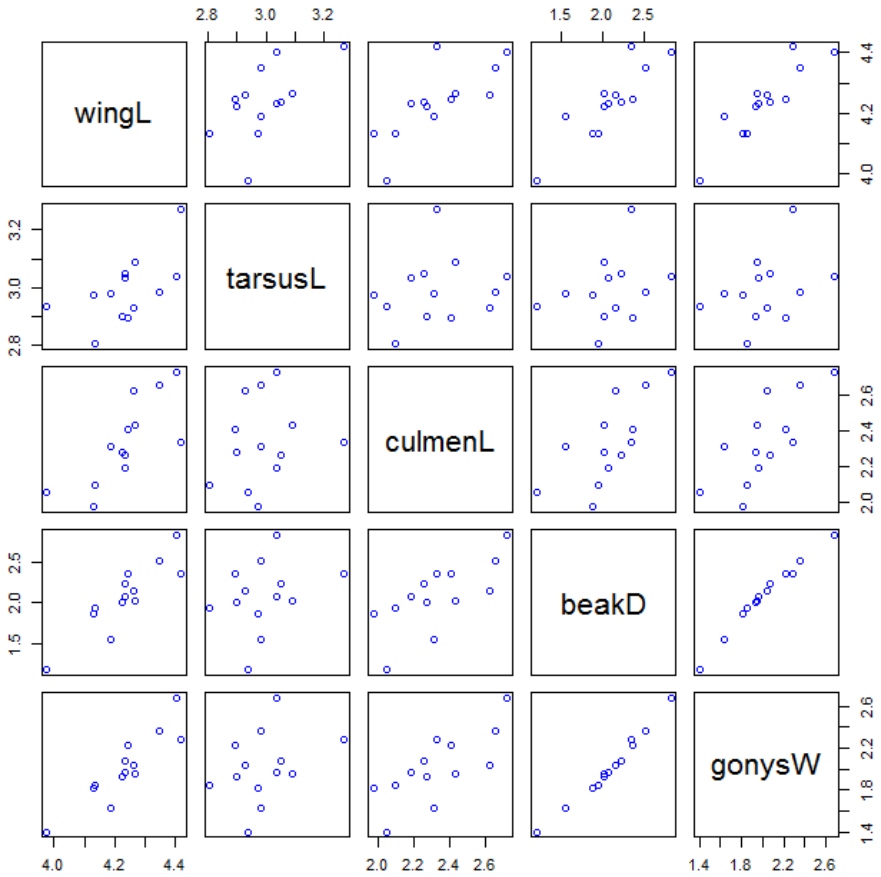
DarwinsFinches.nex

Traits data

	wingL	tarsusL	culmenL	beakD	gonysW
Geospiza magnirostris	4.4042	3.03895	2.724667	2.823767	2.675983
Geospiza conirostris	4.349867	2.9842	2.6544	2.5138	2.360167
Geospiza difficilis	4.224067	2.898917	2.277183	2.0111	1.929983
Geospiza scandens	4.261222	2.929033	2.621789	2.1447	2.036944
Geospiza fortis	4.244008	2.894717	2.407025	2.362658	2.221867
Geospiza fuliginosa	4.132957	2.806514	2.094971	1.941157	1.845379
Cactospiza pallida	4.265425	3.08945	2.43025	2.01635	1.949125
Certhidea olivacea	3.975393	2.936536	2.051843	1.191264	1.401186
Camarhynchus parvulus	4.1316	2.97306	1.97442	1.87354	1.81334
Camarhynchus pauper	4.2325	3.0359	2.187	2.0734	1.9621
Pinaroloxias inornata	4.1886	2.9802	2.3111	1.5475	1.6301
Platyspiza crassirostris	4.419686	3.270543	2.331471	2.347471	2.282443
Camarhynchus psittacula	4.23502	3.04912	2.25964	2.23004	2.07394

DarwinsFinchesTraits.txt

Traits data

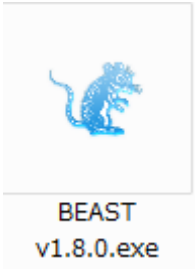


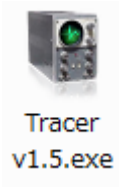
Correlation between traits

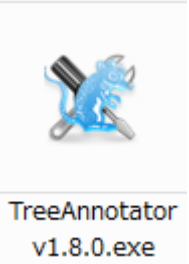
	wingL	tarsusL	culmenL	beakD	gonysW
wingL	1.000	0.593	0.757	0.881	0.899
tarsusL	0.593	1.000	0.192	0.298	0.354
culmenL	0.757	0.192	1.000	0.714	0.752
beakD	0.881	0.298	0.714	1.000	0.988
gonysW	0.899	0.354	0.752	0.988	1.000

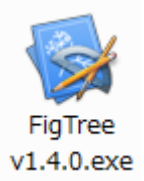
Analyze by Beast

1. Make a control file in xml format. ------ 

2. Run MCMC ------ 

3. View the MCMC sample of the parameters --------- 

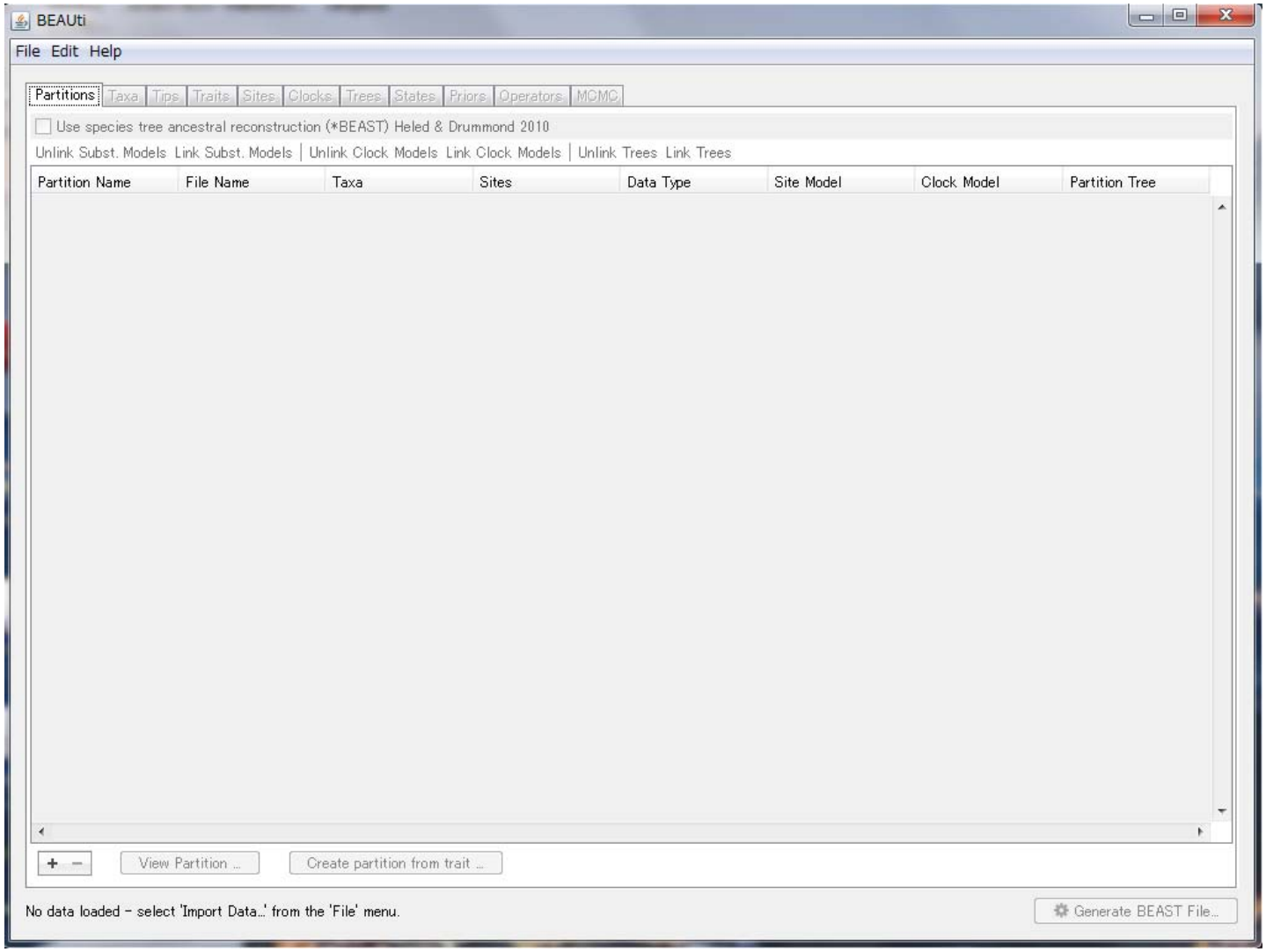
4. Summarize MCMC sample of the labeled trees ---------- 

5. Visualize the posterior distribution of the tree ------ 


Specify models
and priors by
BEAUti

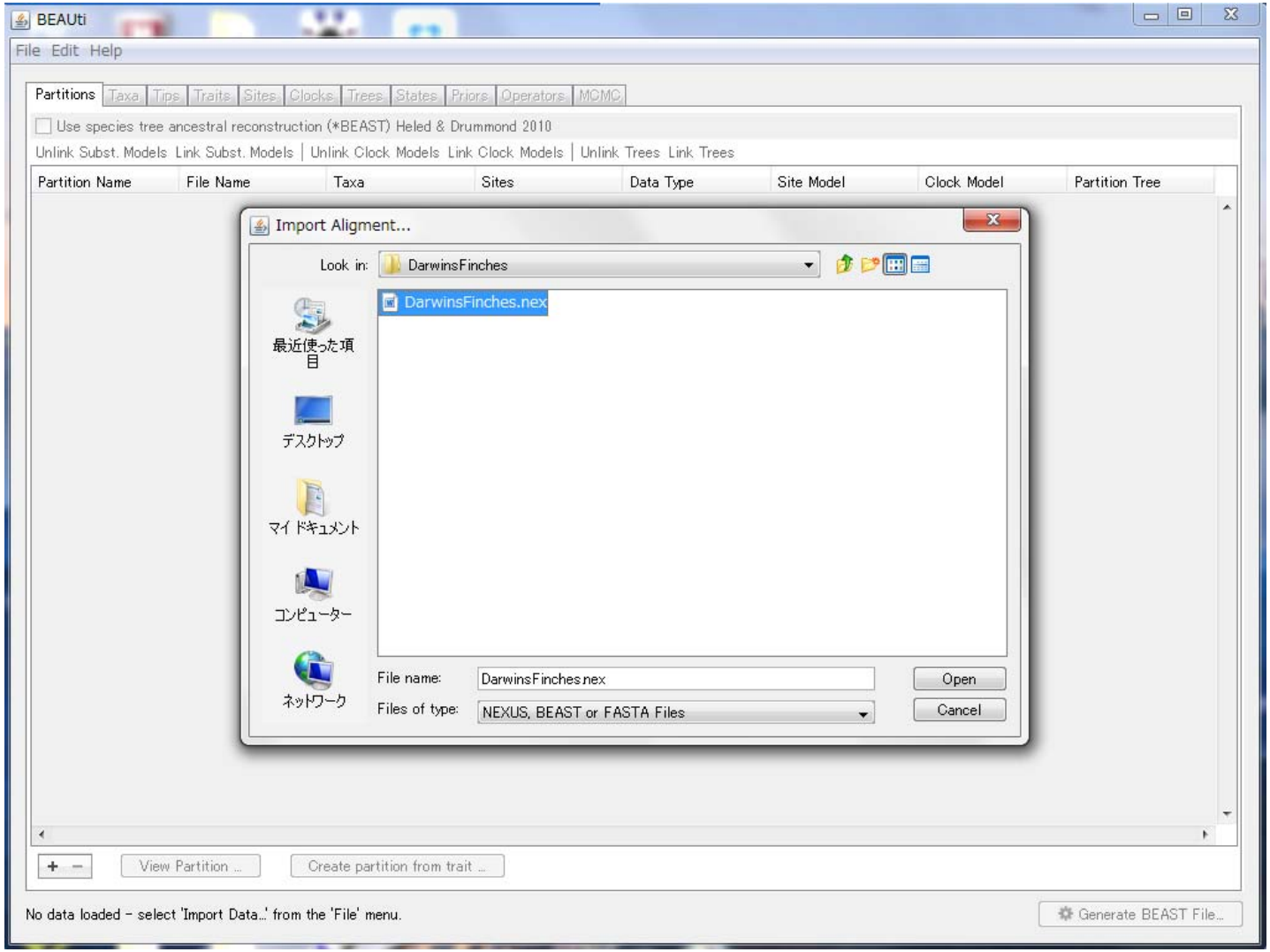
Start BEAUTi

BEAUti
v1.8.0.exe



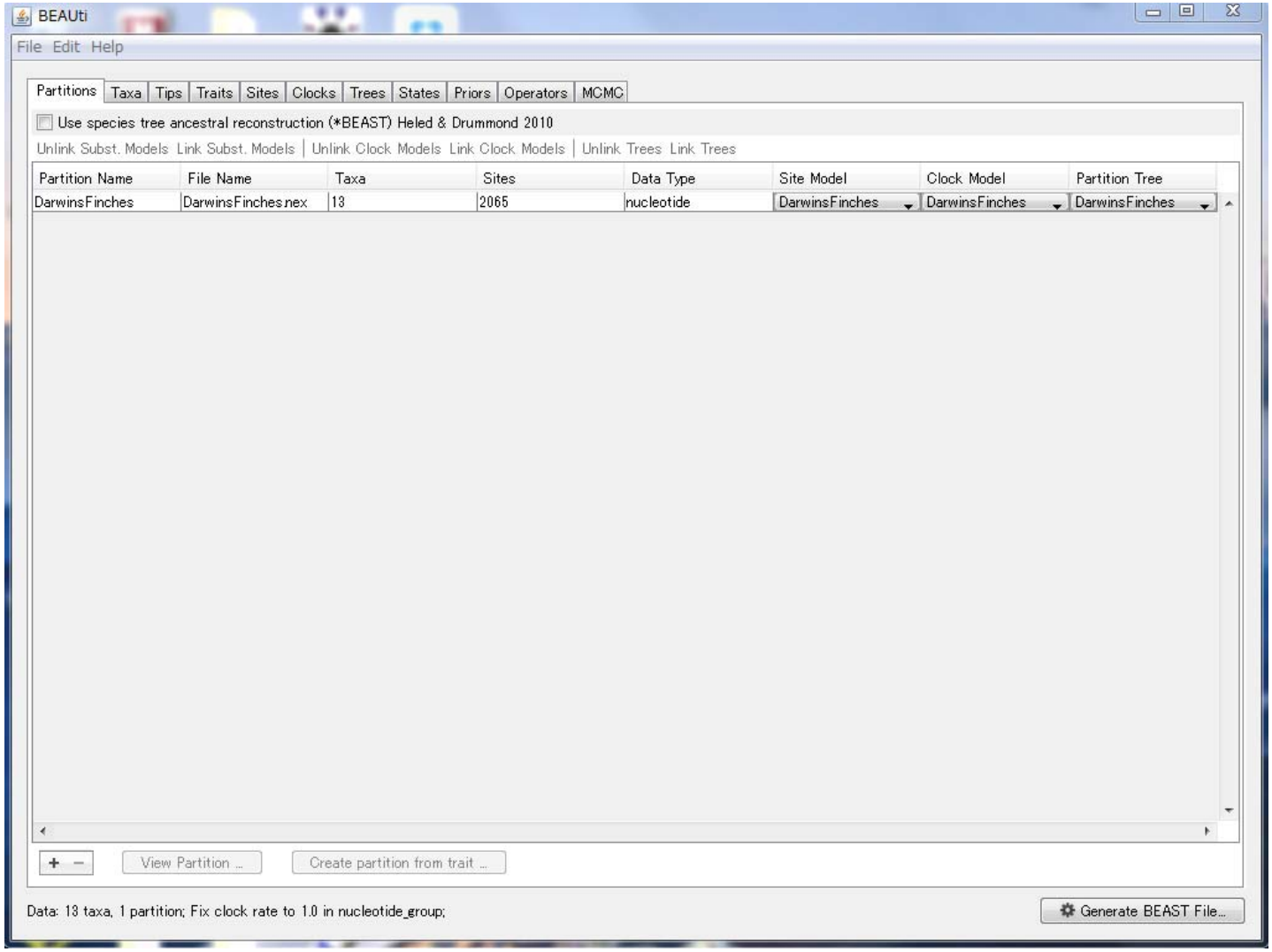
Import data

[File][Import Data]



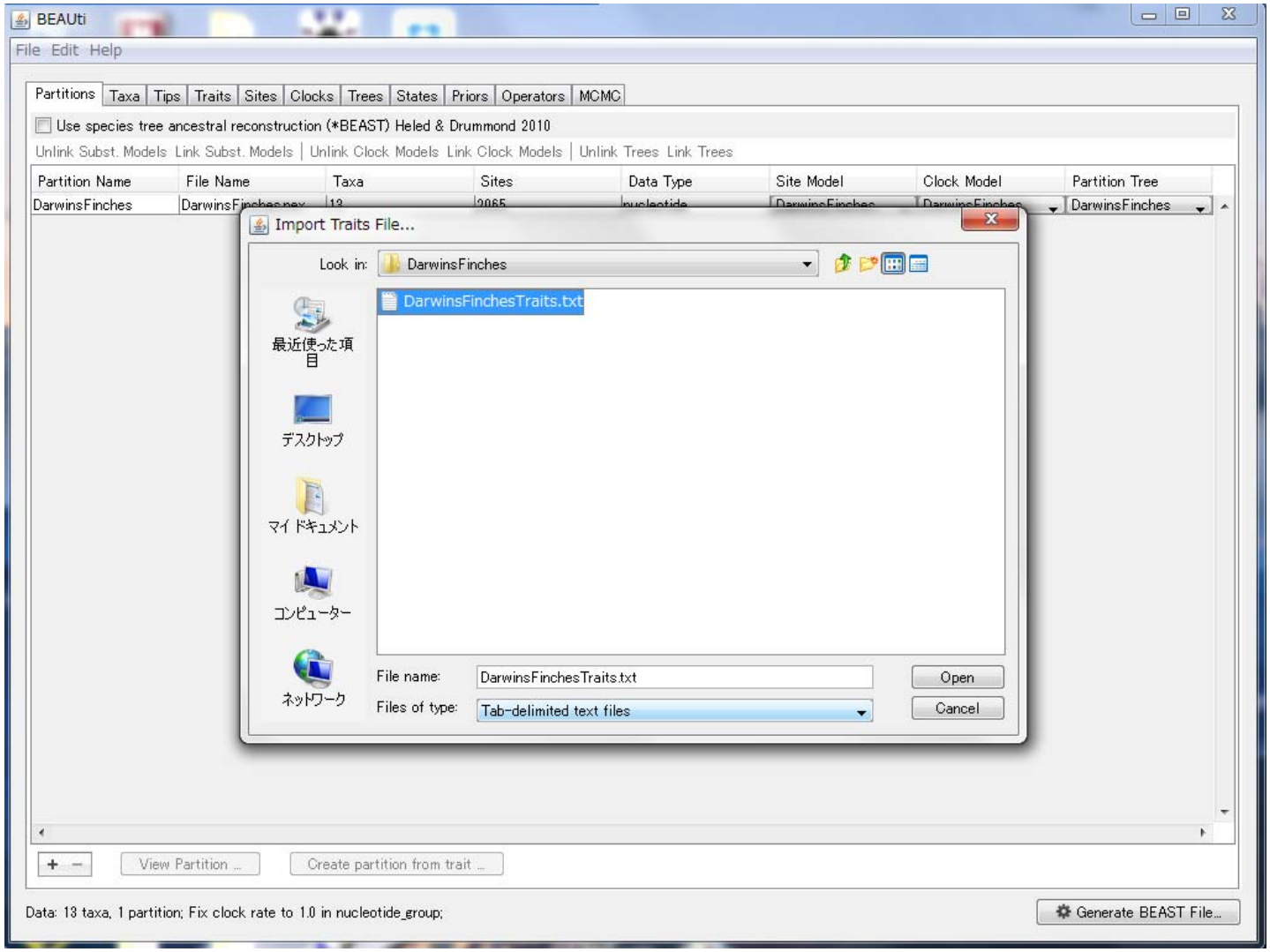
DarwinsFinches is listed in partitions

BEAUti
v1.8.0.exe

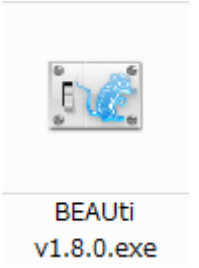


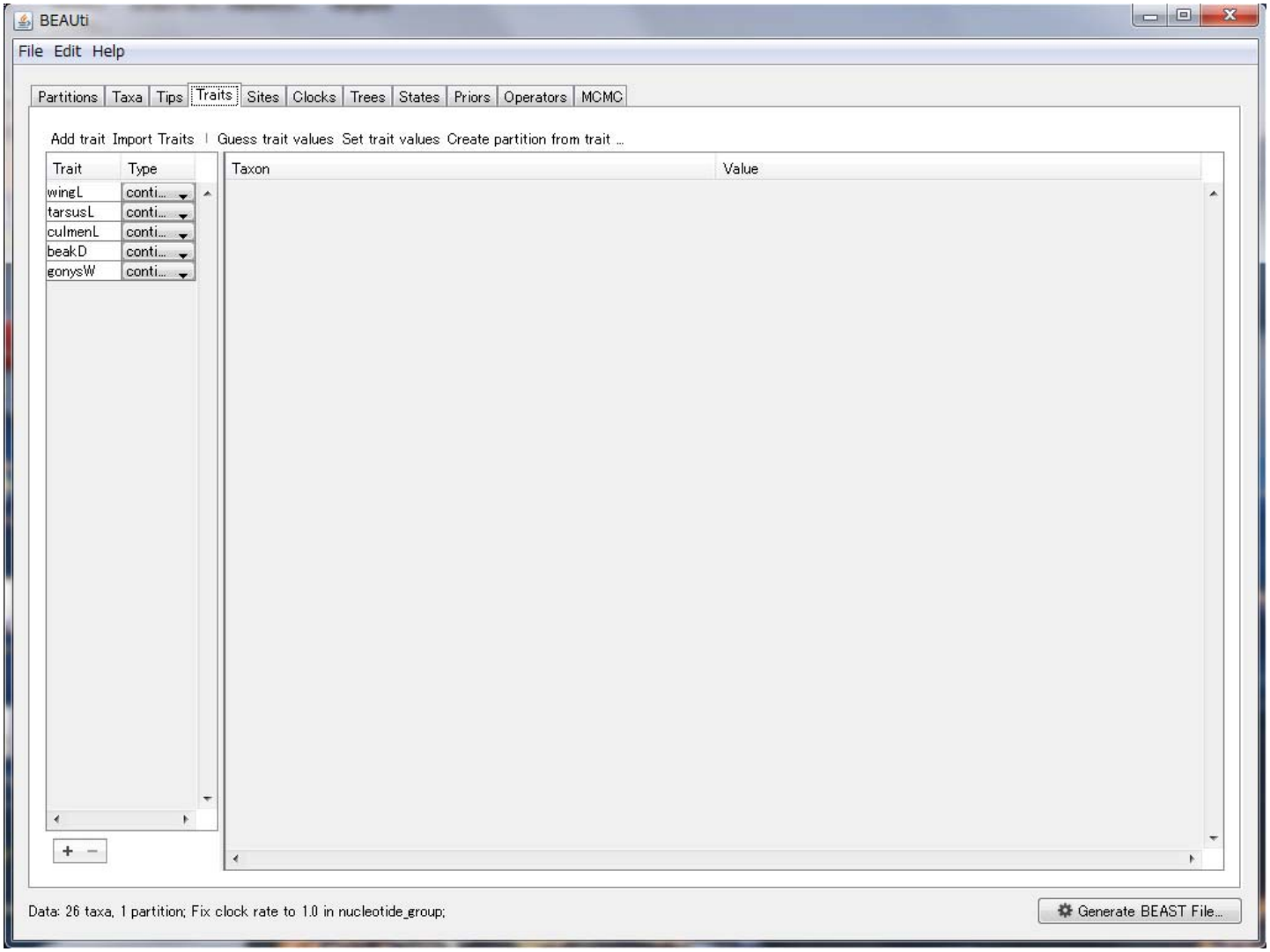
Import traits data

[File][Import Traits]

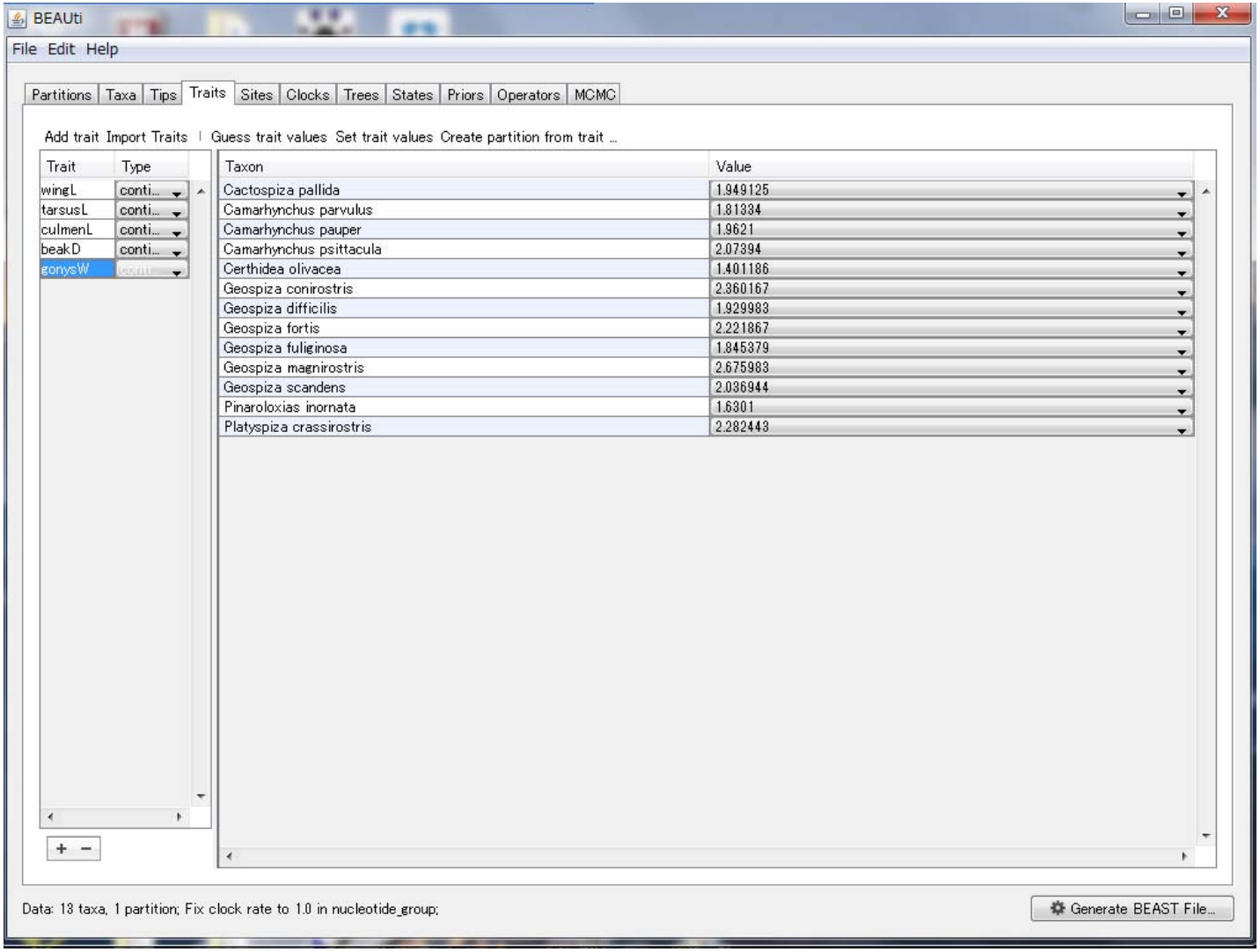


Traits data and their types



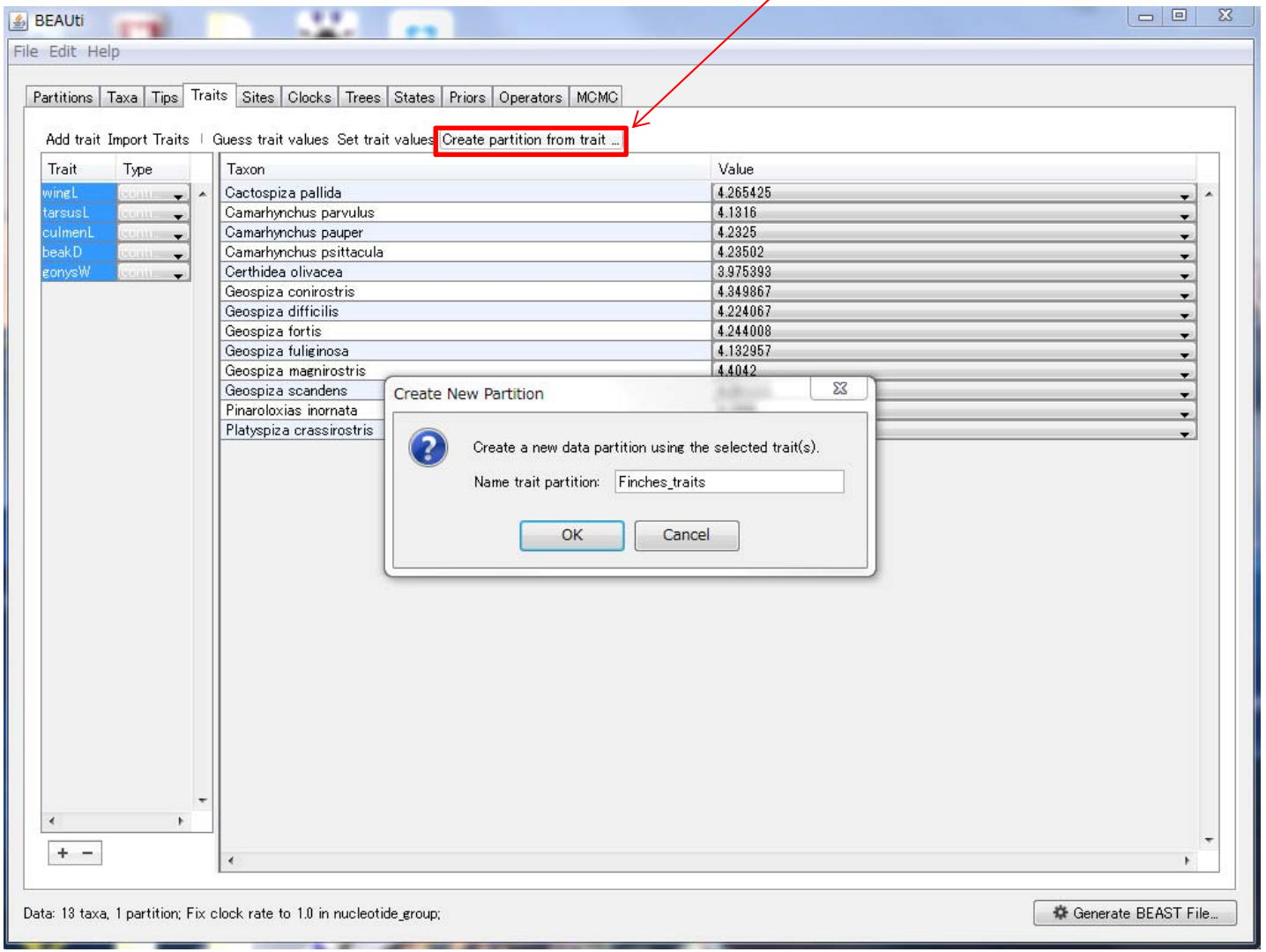


Look at the traits data



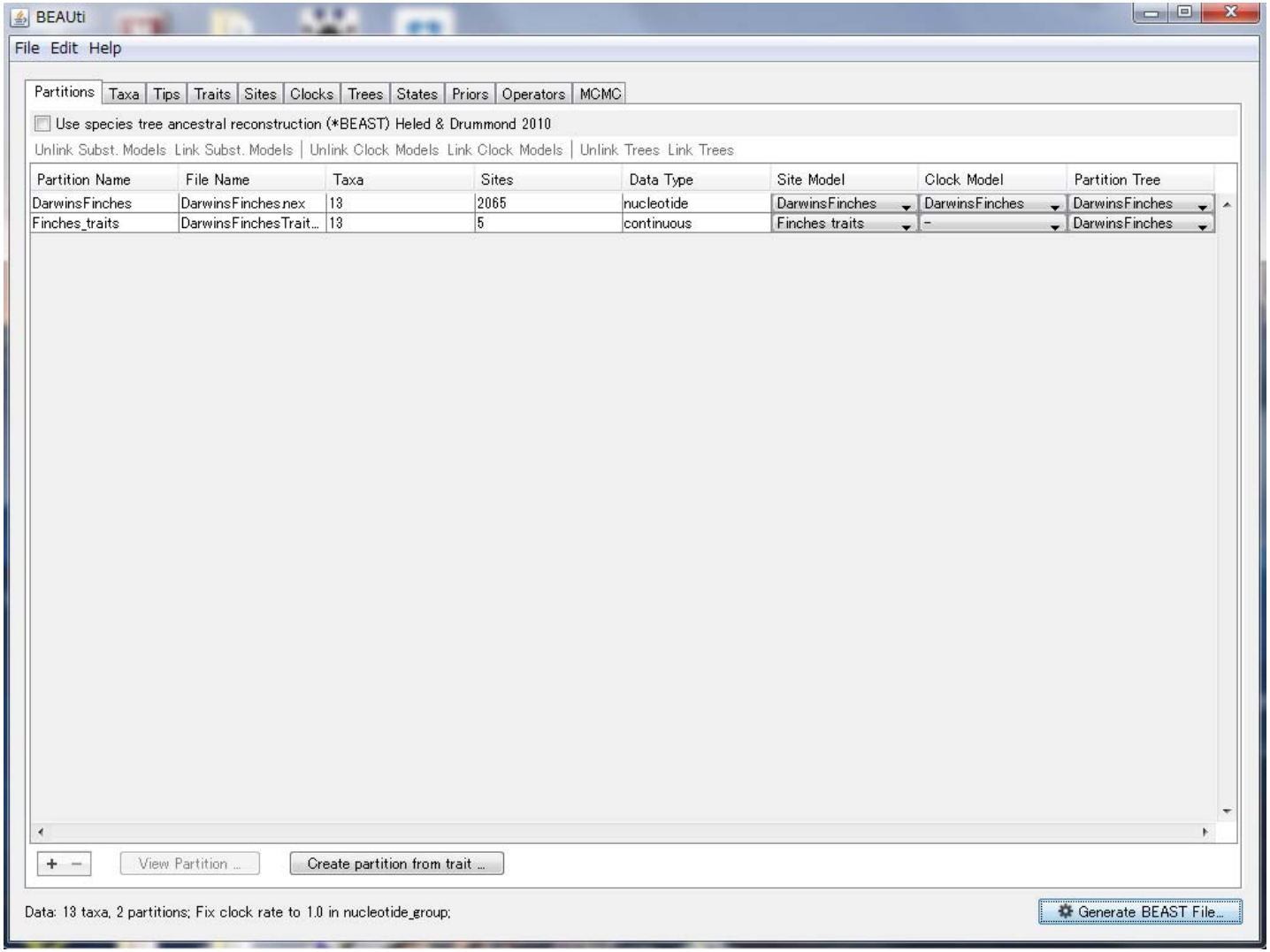
Register all traits together as a single partition named Finches_traits for multivariate analysis

BEAUti
v1.8.0.exe



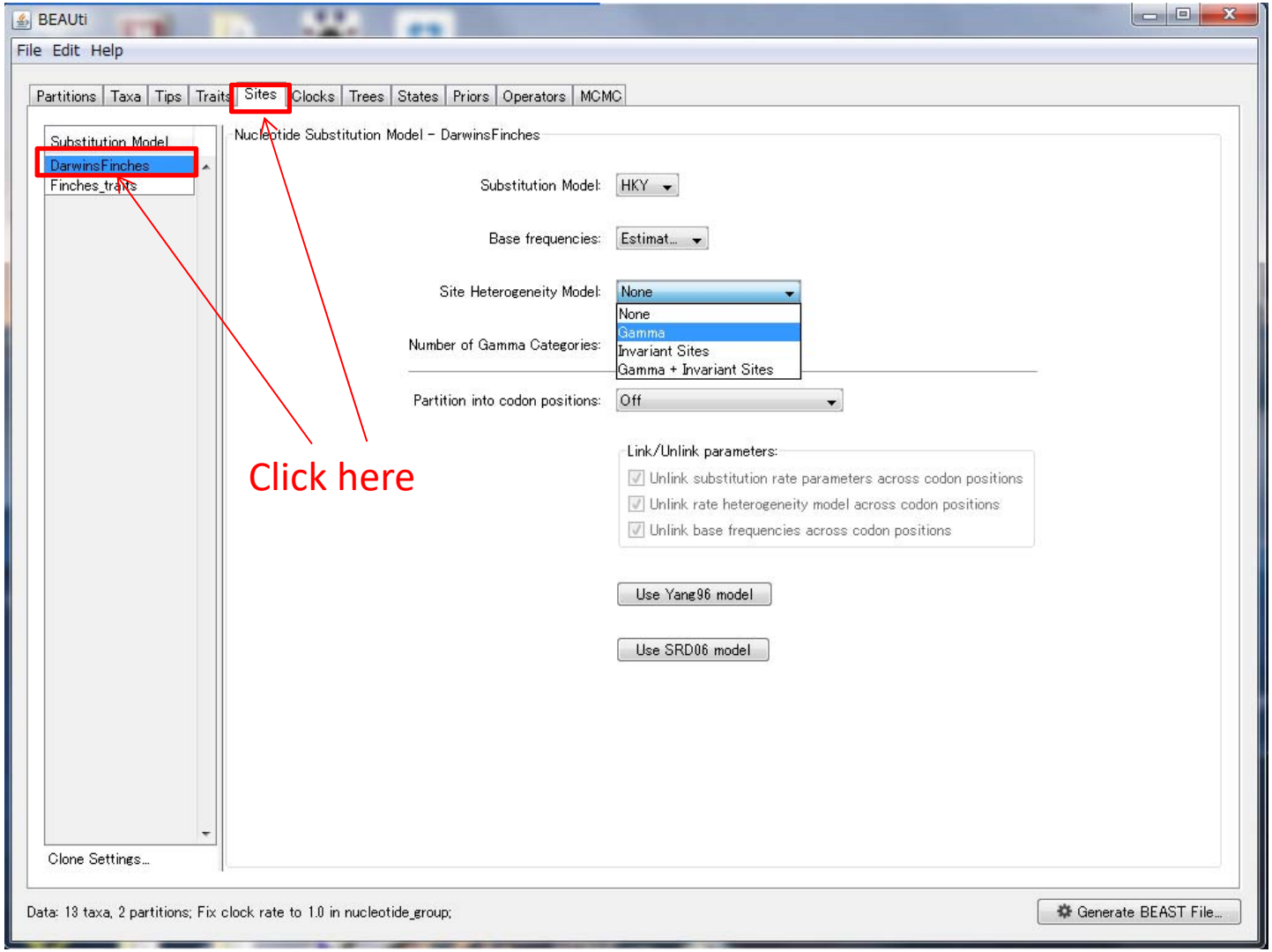
Two partitions are listed

BEAUti
v1.8.0.exe



Specify the model of sequence evolution

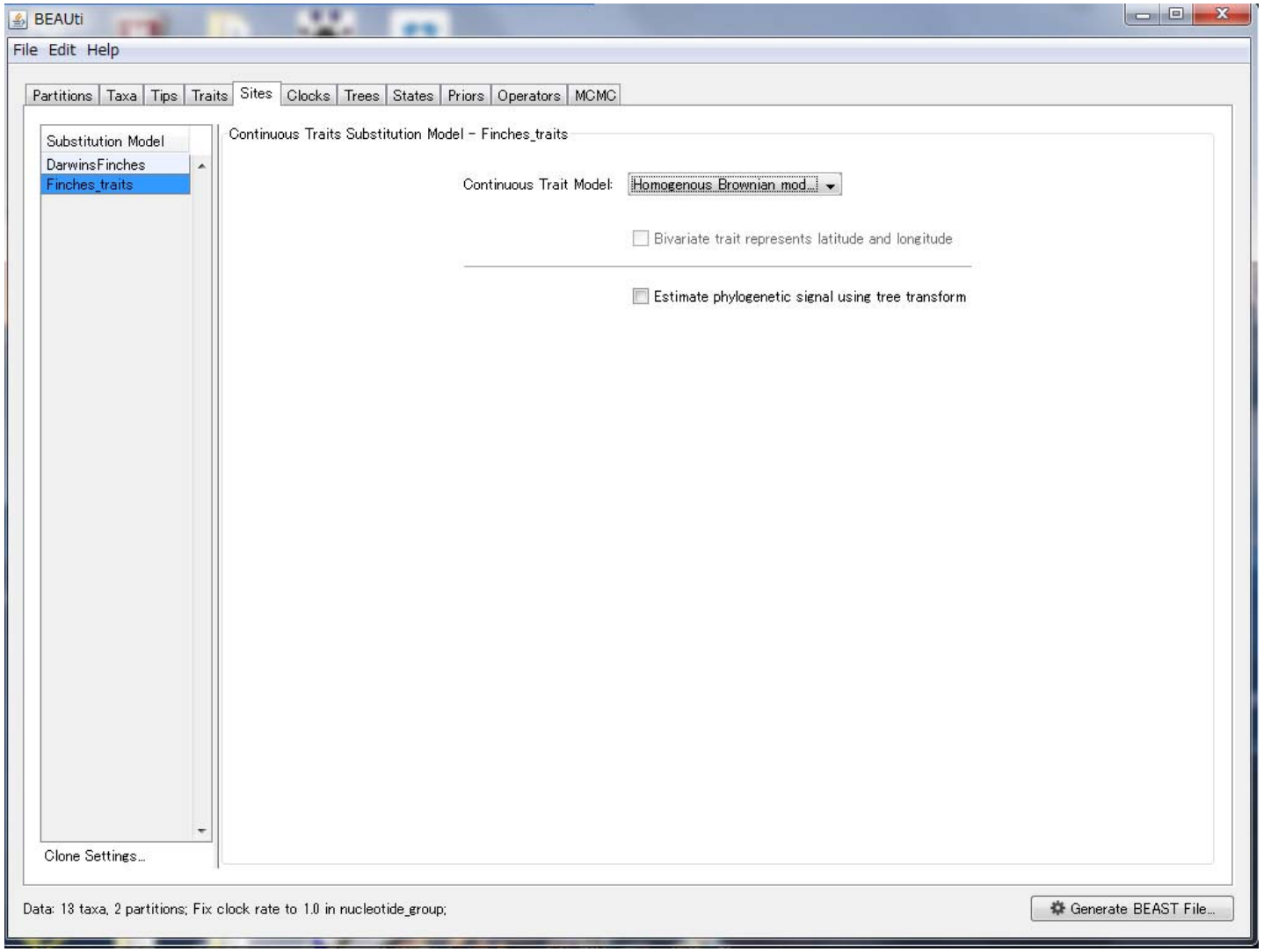
Choose HKY+G this time



Specify the model of traits evolution

BEAUti
v1.8.0.exe

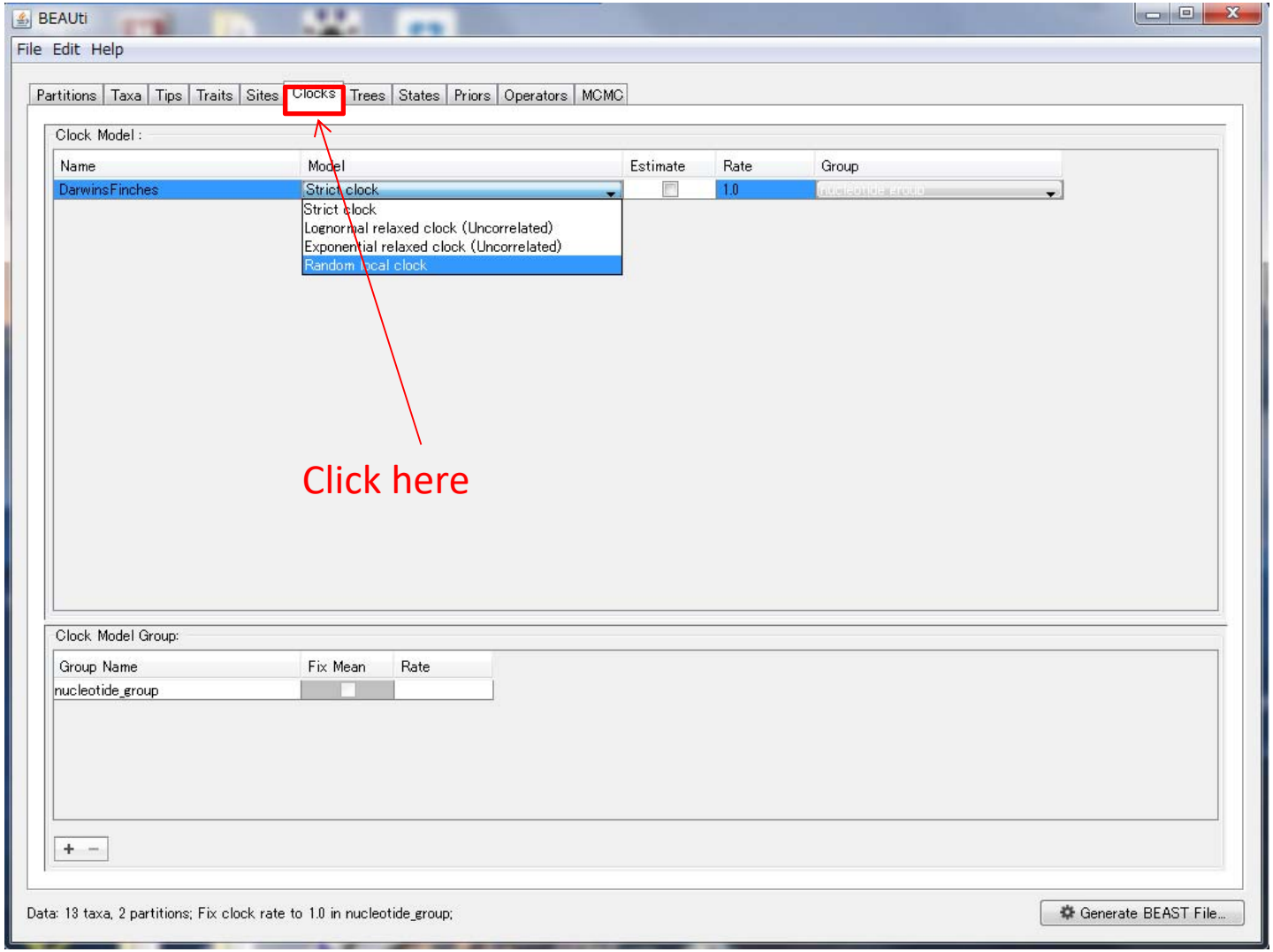
Choose Brownian motion



Specify the prior on the stochastic molecular clock

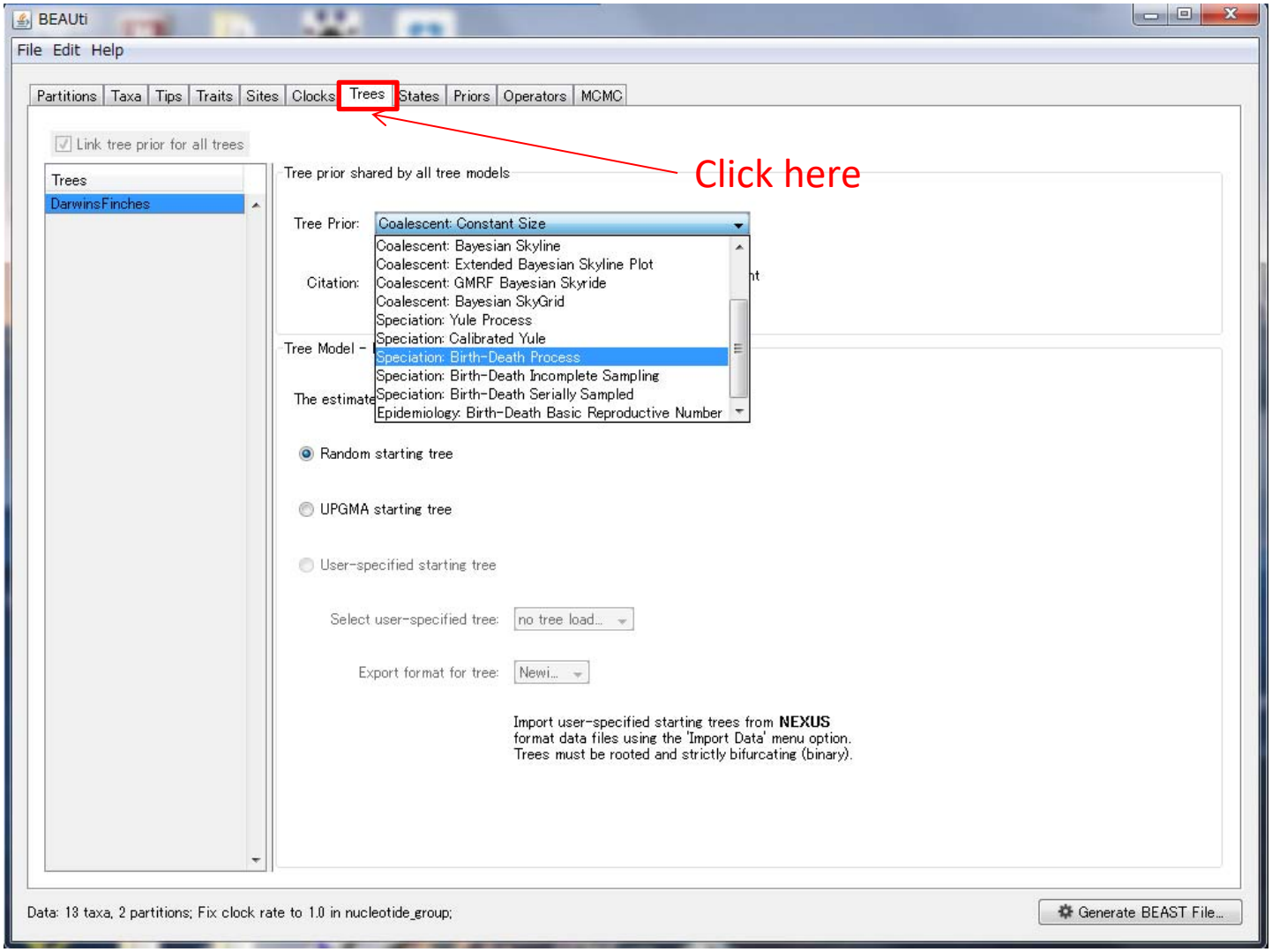
BEAUti
v1.8.0.exe

Choose random local clock with mean rate of 1.0

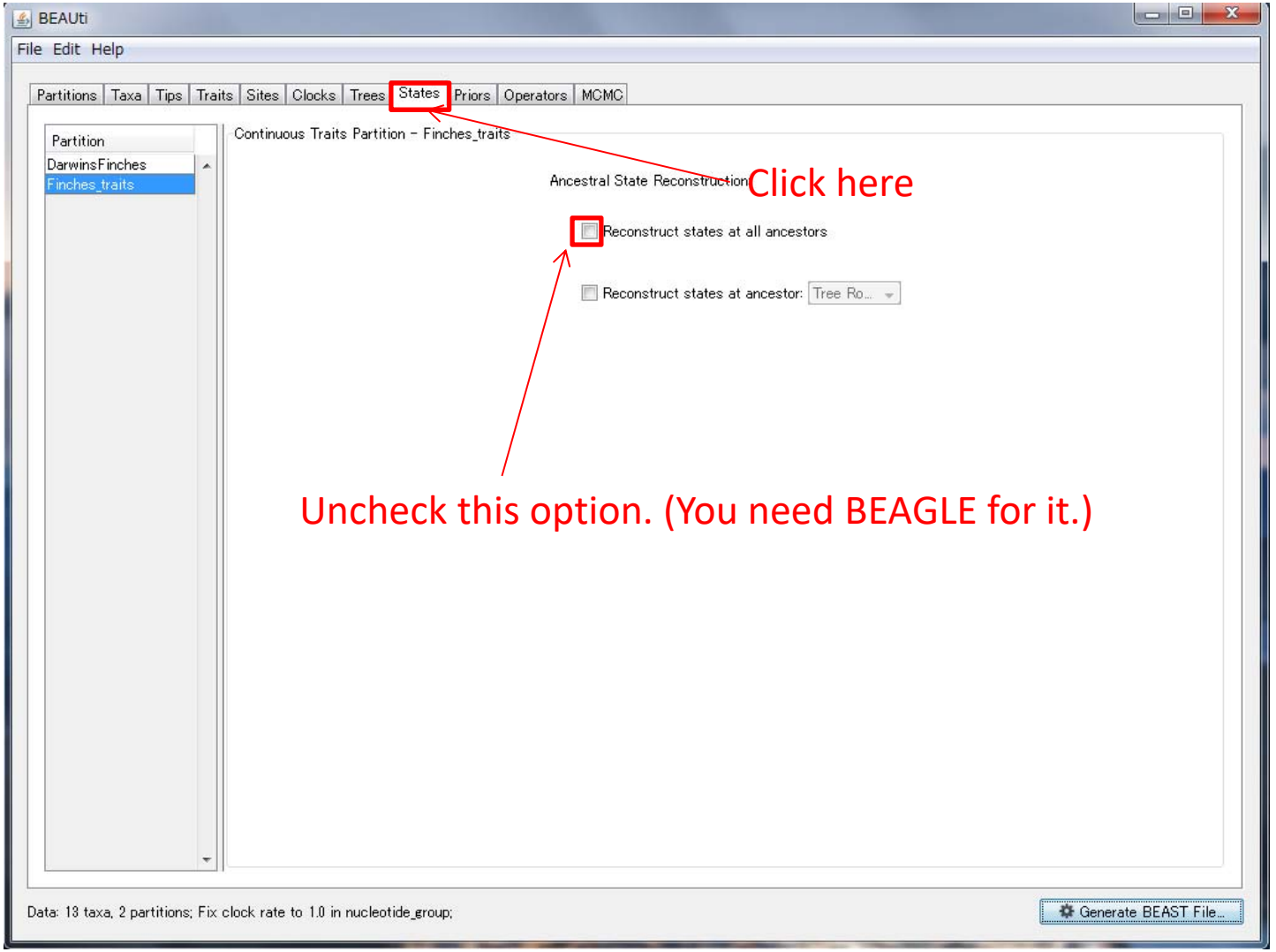


Specify the prior on the divergence times

Birth-death process for speciation and extinction

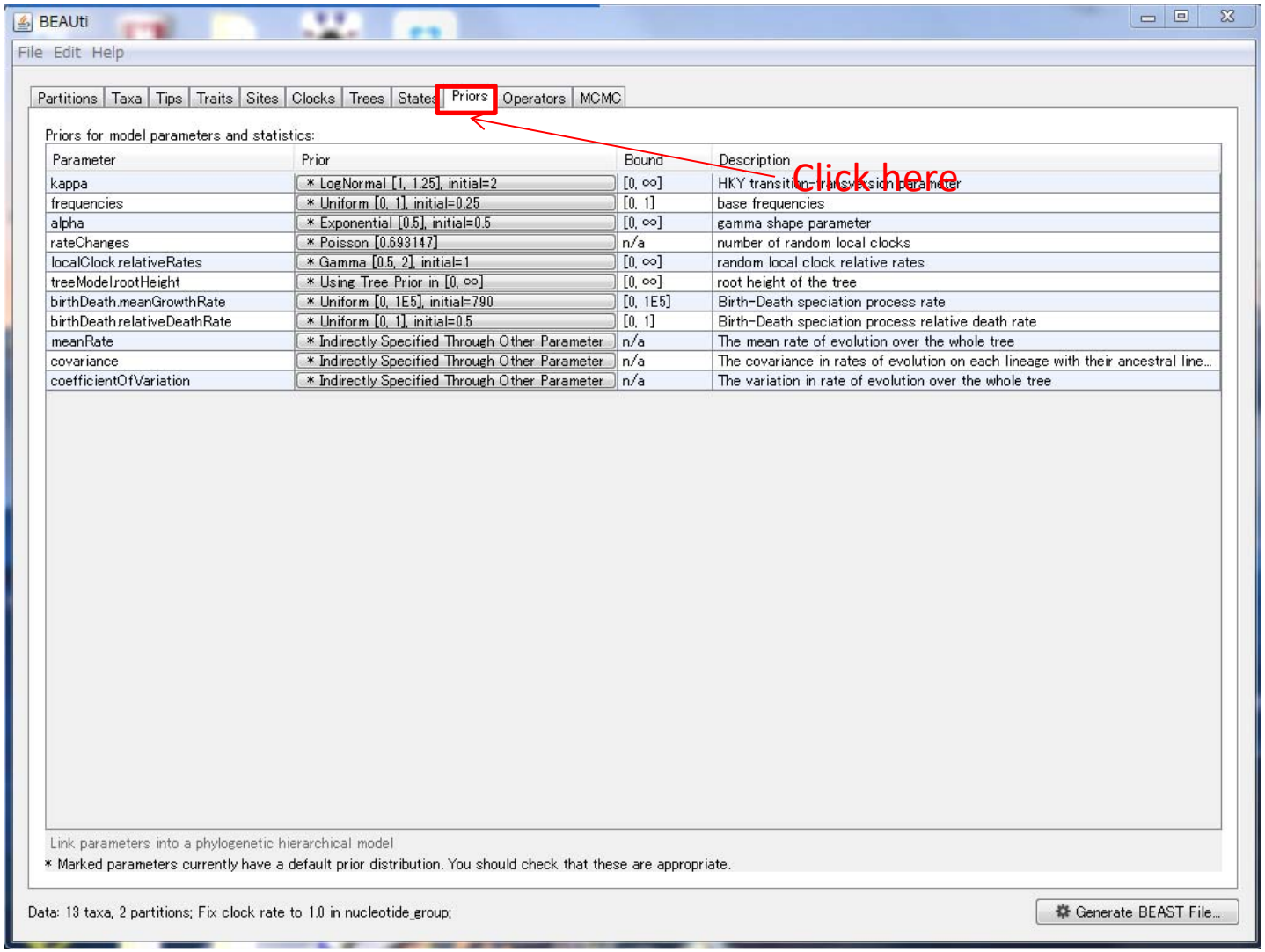


Uncheck the option of the ancestral states reconstruction

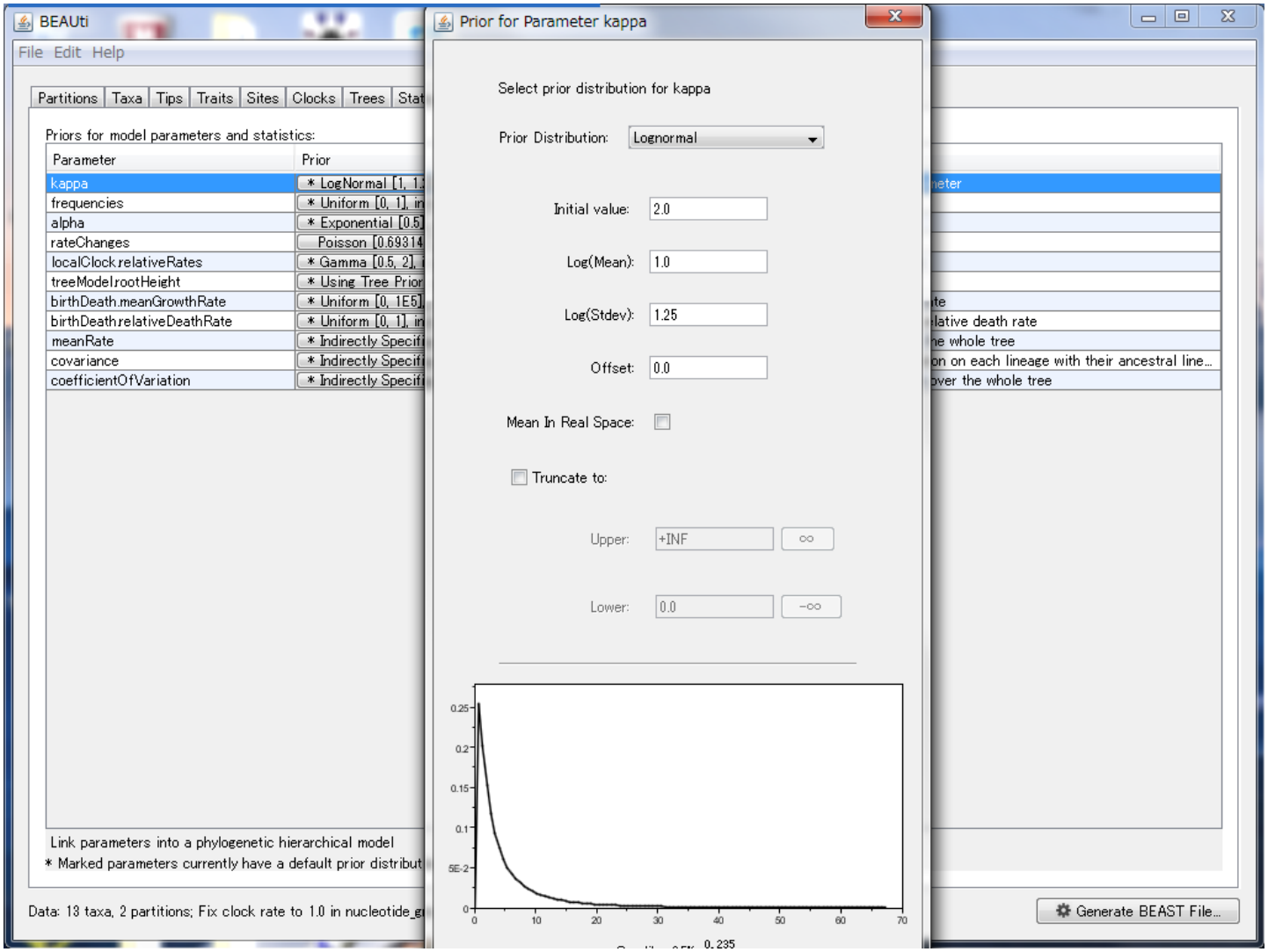


Confirm the default of the priors on the parameters

BEAUti
v1.8.0.exe

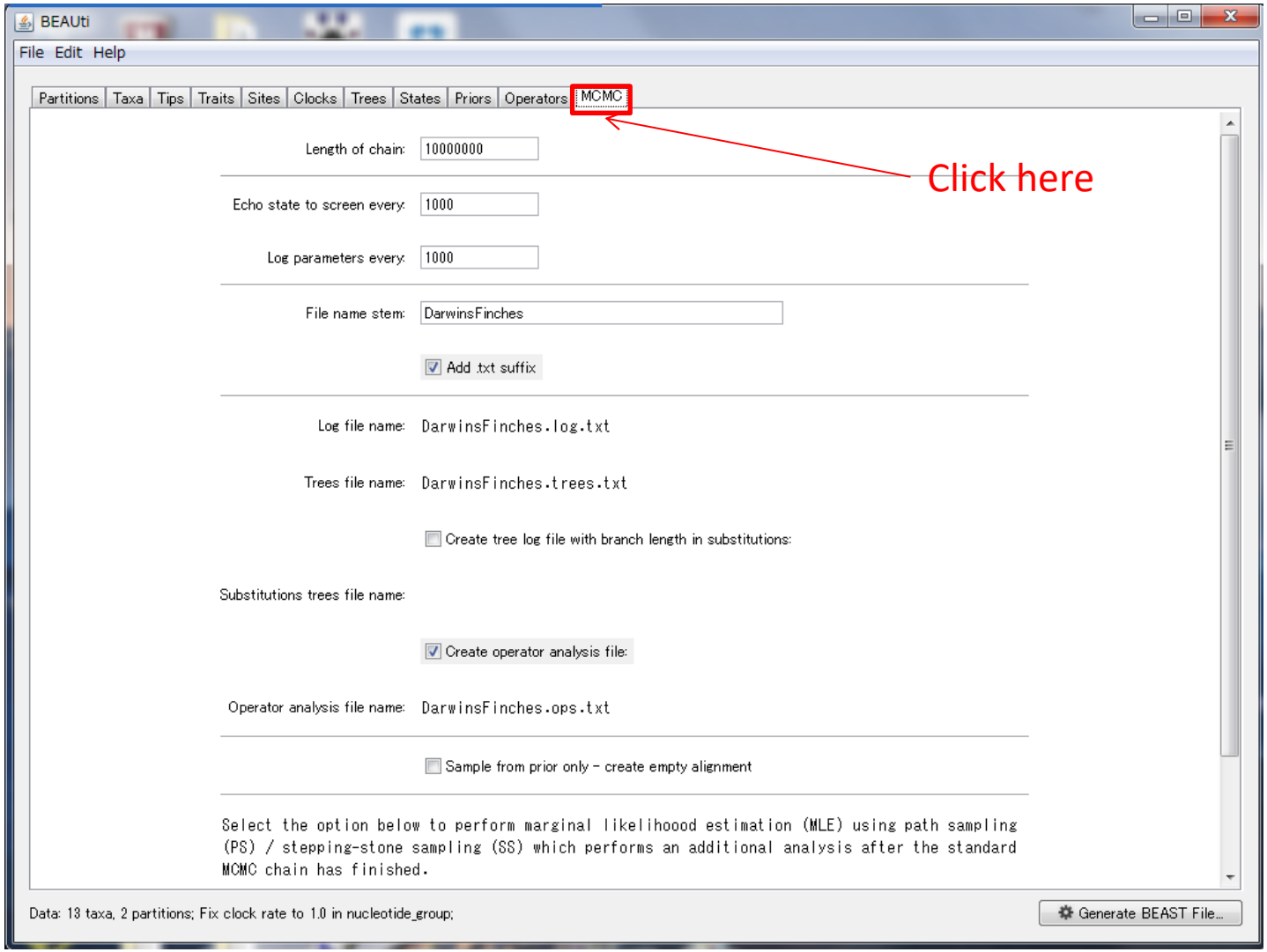


You can view the form of the prior distributions

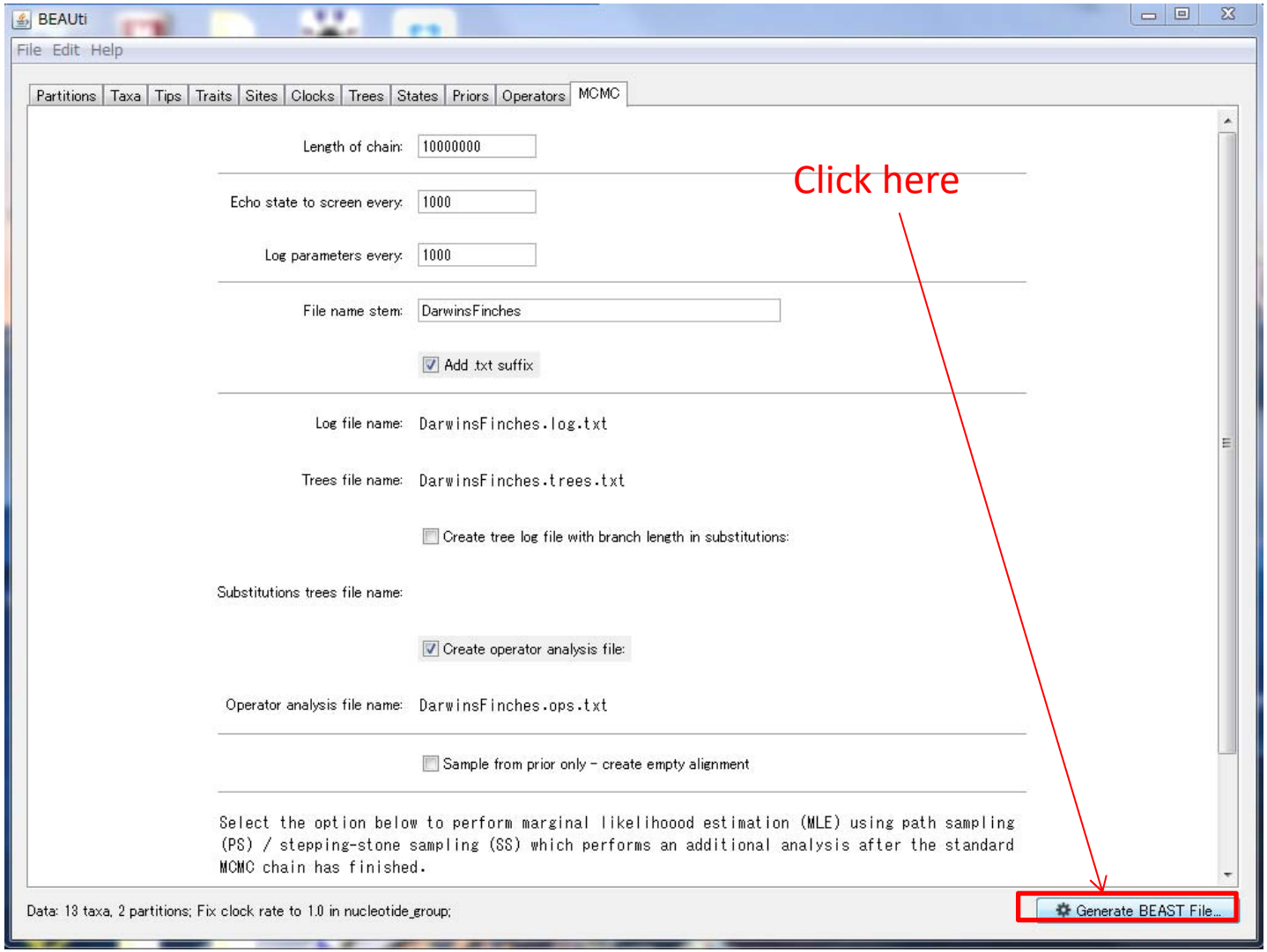


Specify the settings of MCMC

BEAUti
v1.8.0.exe

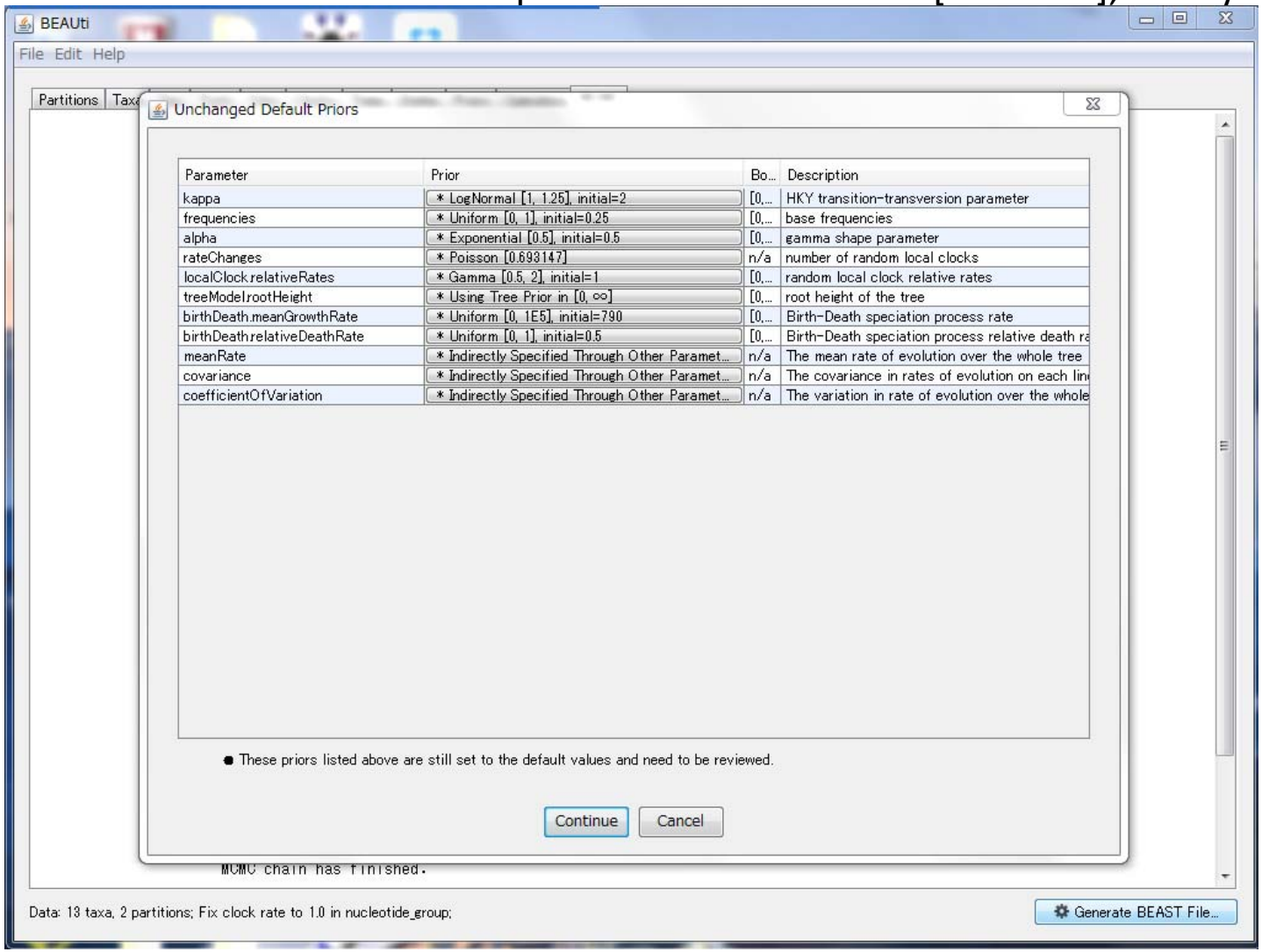


Save as a file of XML format

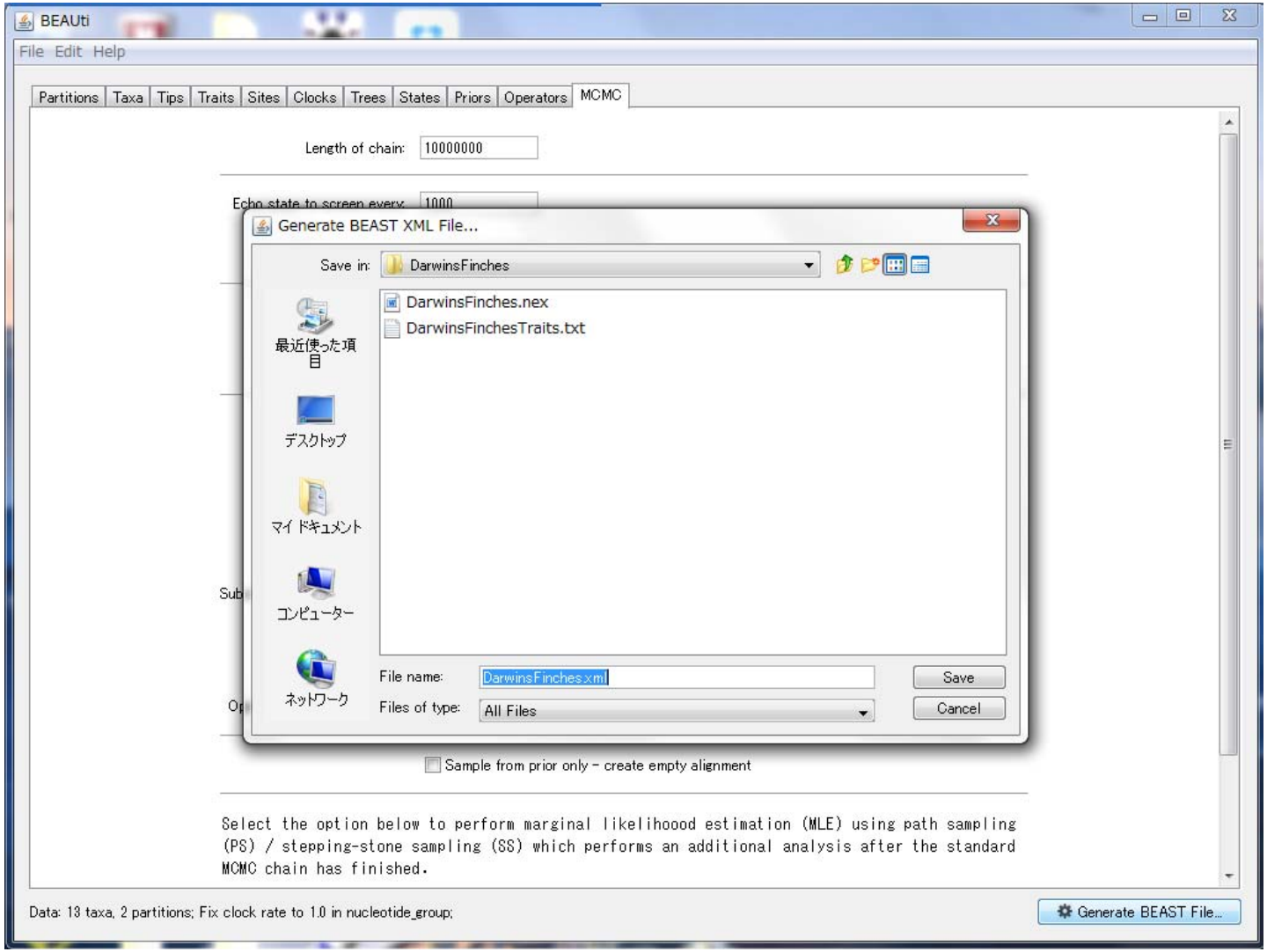


Save as a file of XML format

You will be asked to confirm the prior distributions. Click [continue], if they are OK.

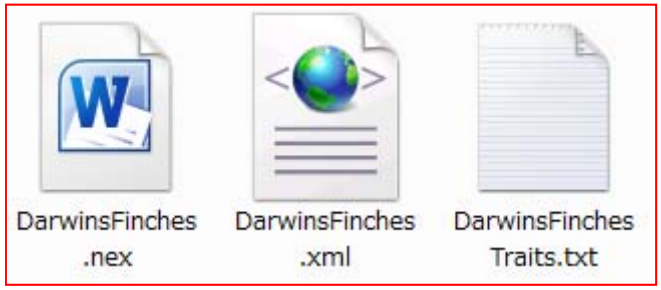


Save as a file of XML format



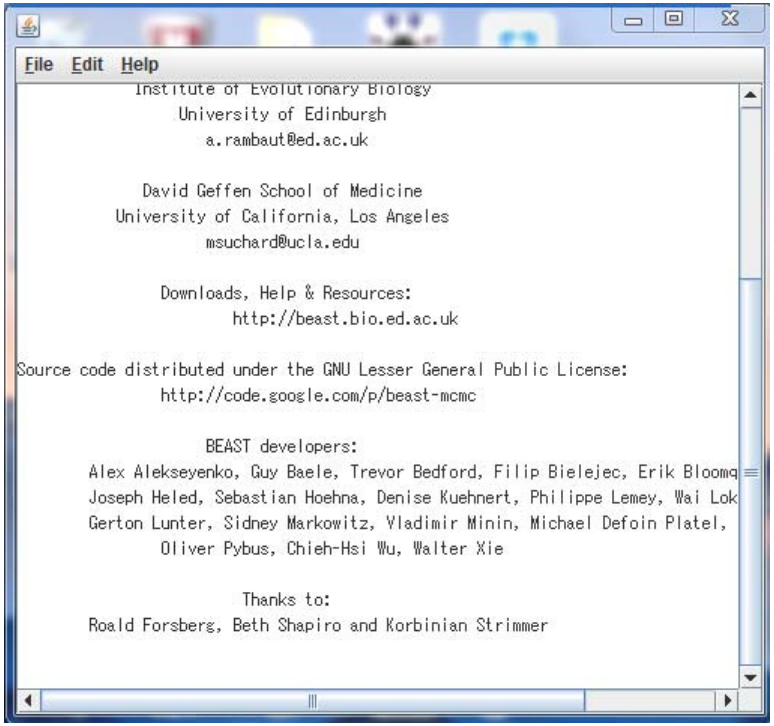
Confirm the working folder

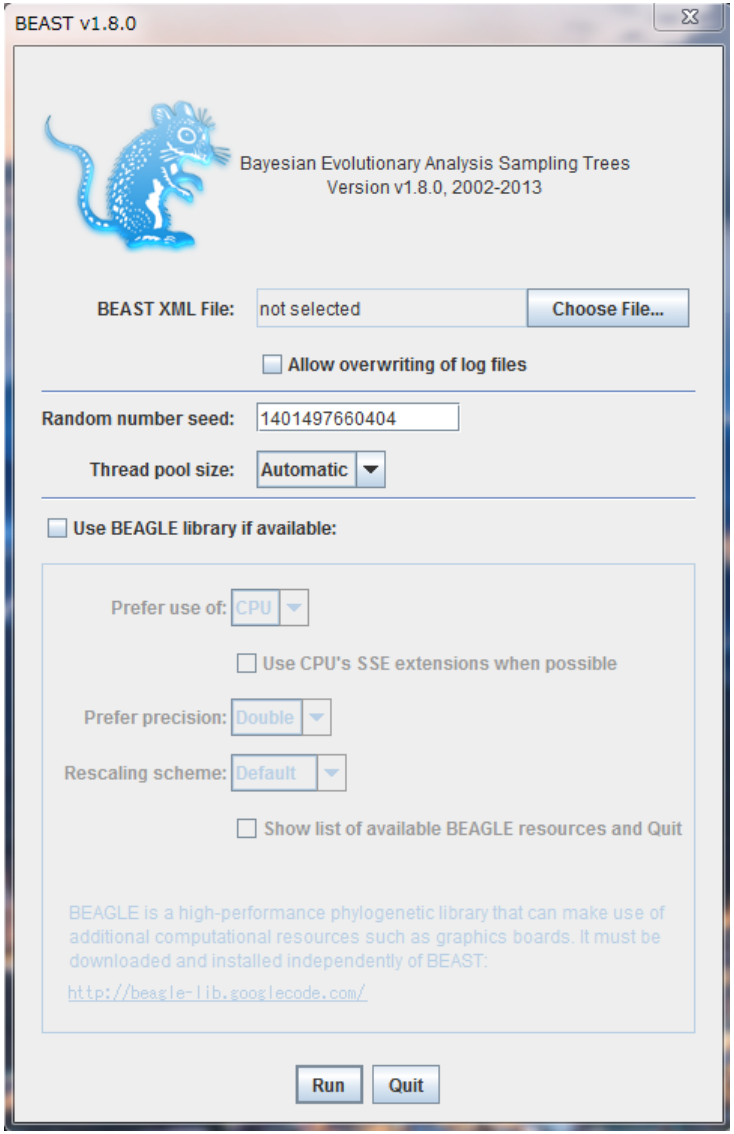
If you find the xml file in the working folder, close BEAUti.

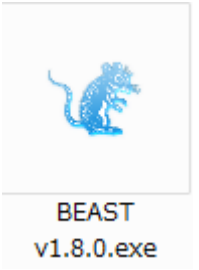



Run BEAST

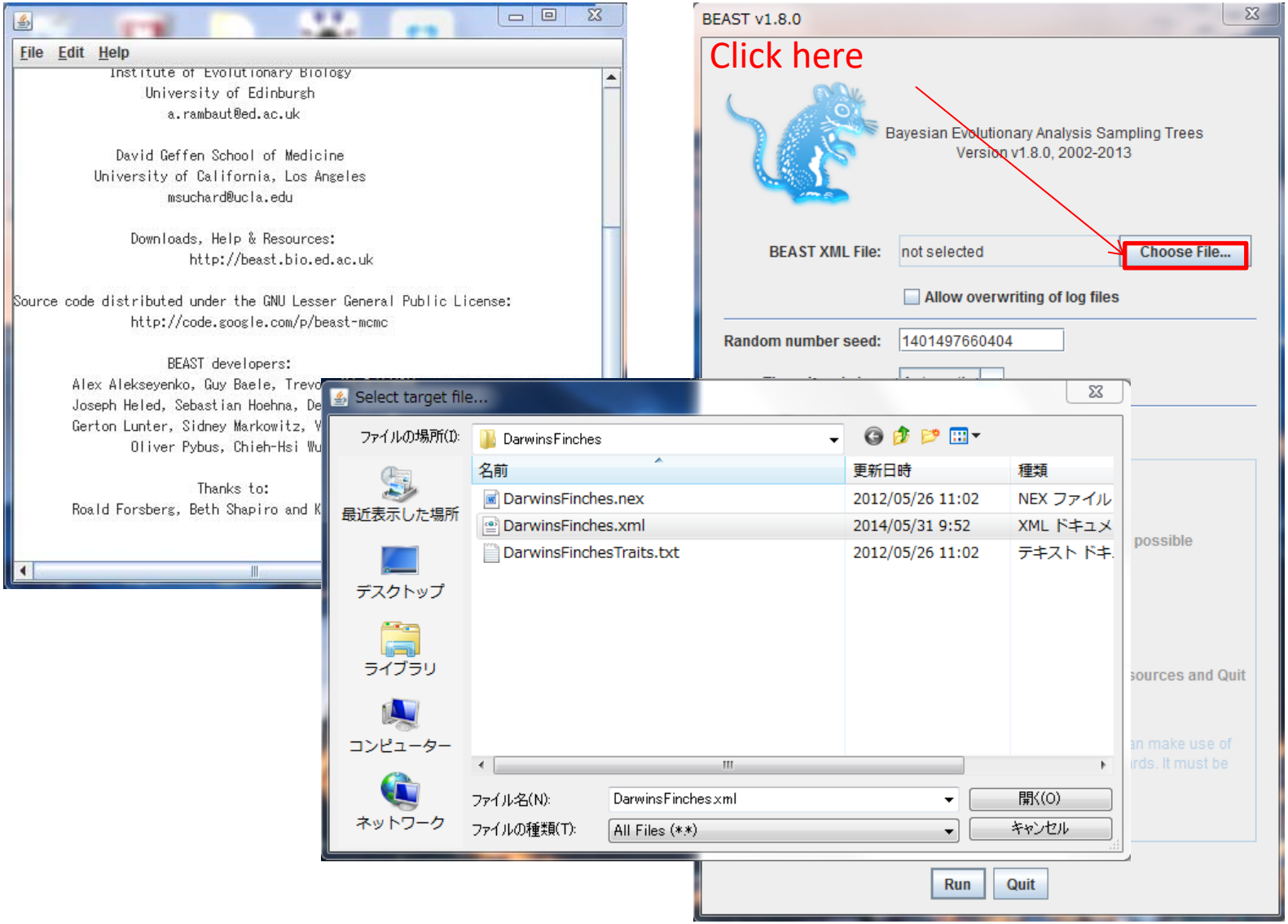
Start BEAST


File Edit Help
Institute of Evolutionary Biology
University of Edinburgh
a.rambaut@ed.ac.uk
David Geffen School of Medicine
University of California, Los Angeles
msuchard@ucla.edu
Downloads, Help & Resources:
http://beast.bio.ed.ac.uk
Source code distributed under the GNU Lesser General Public License:
http://code.google.com/p/beast-mcmc
BEAST developers:
Alex Alekseyenko, Guy Baele, Trevor Bedford, Filip Bielejec, Erik Bloomq
Joseph Heled, Sebastian Hoehna, Denise Kuehnert, Philippe Lemey, Wai Lok
Gerton Lunter, Sidney Markowitz, Vladimir Minin, Michael Defoin Platel,
Oliver Pybus, Chieh-Hsi Wu, Walter Xie
Thanks to:
Roald Forsberg, Beth Shapiro and Korbinian Strimmer


BEAST v1.8.0
Bayesian Evolutionary Analysis Sampling Trees
Version v1.8.0, 2002-2013
BEAST XML File:
not selected
Choose File...
Allow overwriting of log files
Random number seed:
1401497660404
Thread pool size:
Automatic
Use BEAGLE library if available:
Prefer use of:
CPU
Use CPU's SSE extensions when possible
Prefer precision:
Double
Rescaling scheme:
Default
Show list of available BEAGLE resources and Quit
BEAGLE is a high-performance phylogenetic library that can make use of additional computational resources such as graphics boards. It must be downloaded and installed independently of BEAST:
http://beagle-lib.googlecode.com/
Run
Quit

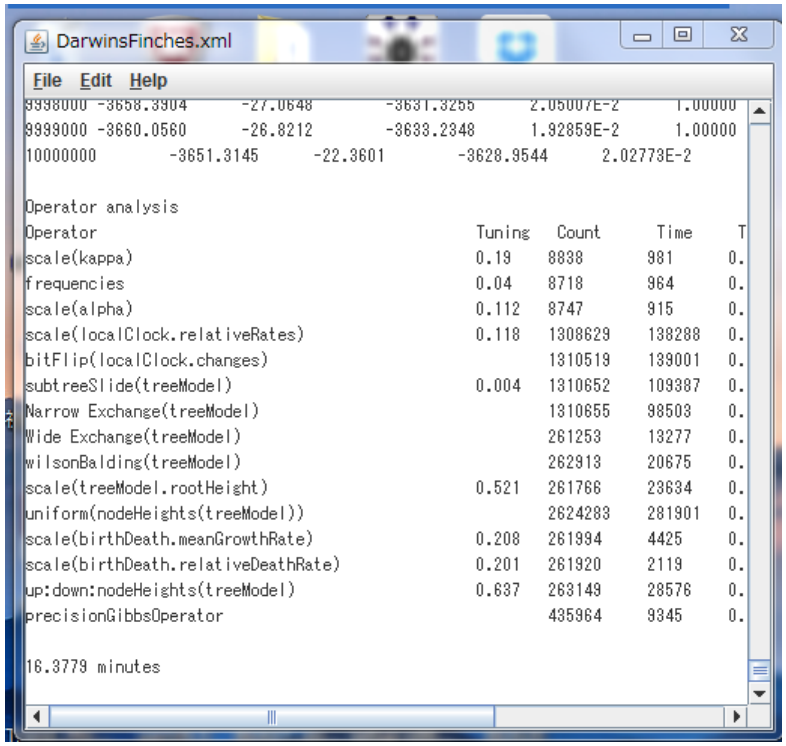

BEAST
v1.8.0.exe

Specify the saved BEAST XML file

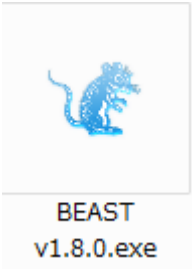


Click [Run], after specifying the XML file.

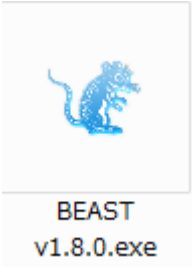
MCMC starts

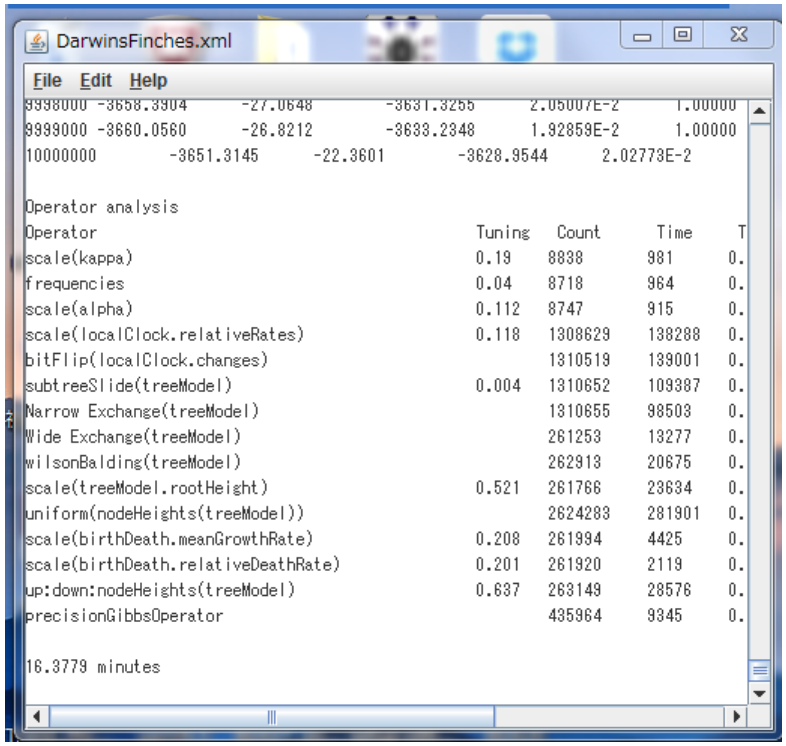


It may take some time.

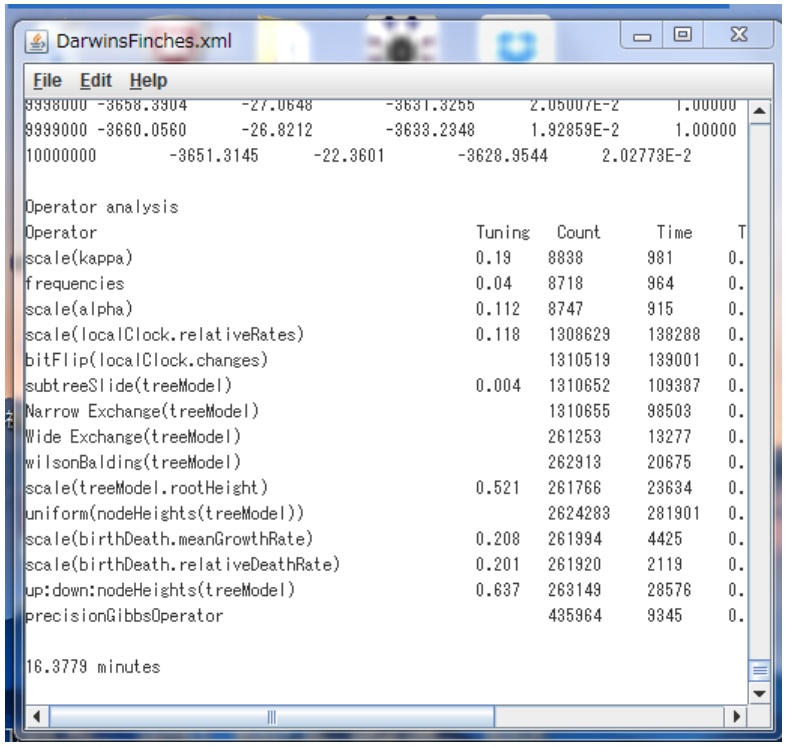


Confirm the output files in the working folder





Confirm the output files in the working folder

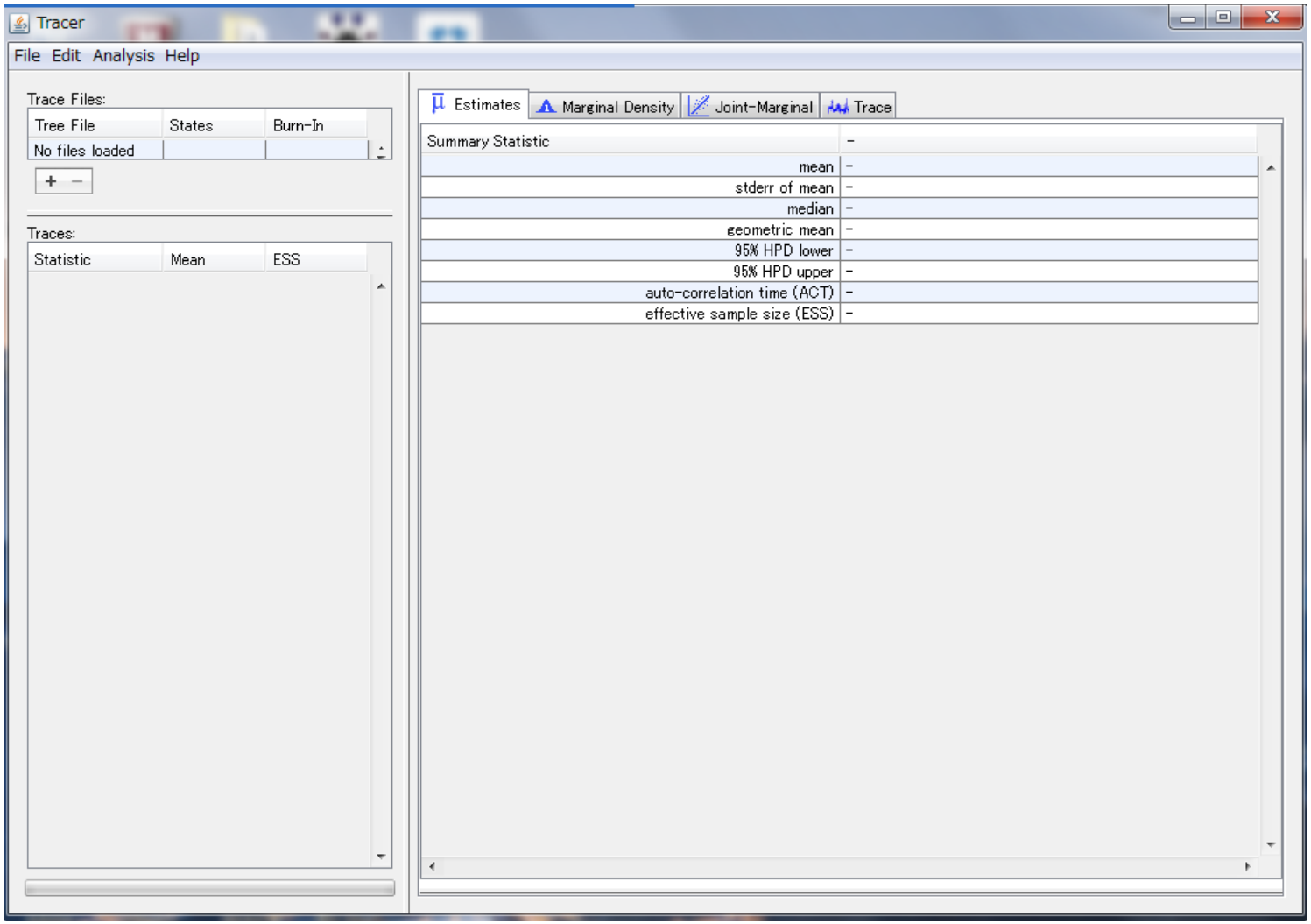


MCMC sample of the parameters

MCMC sample of the trees

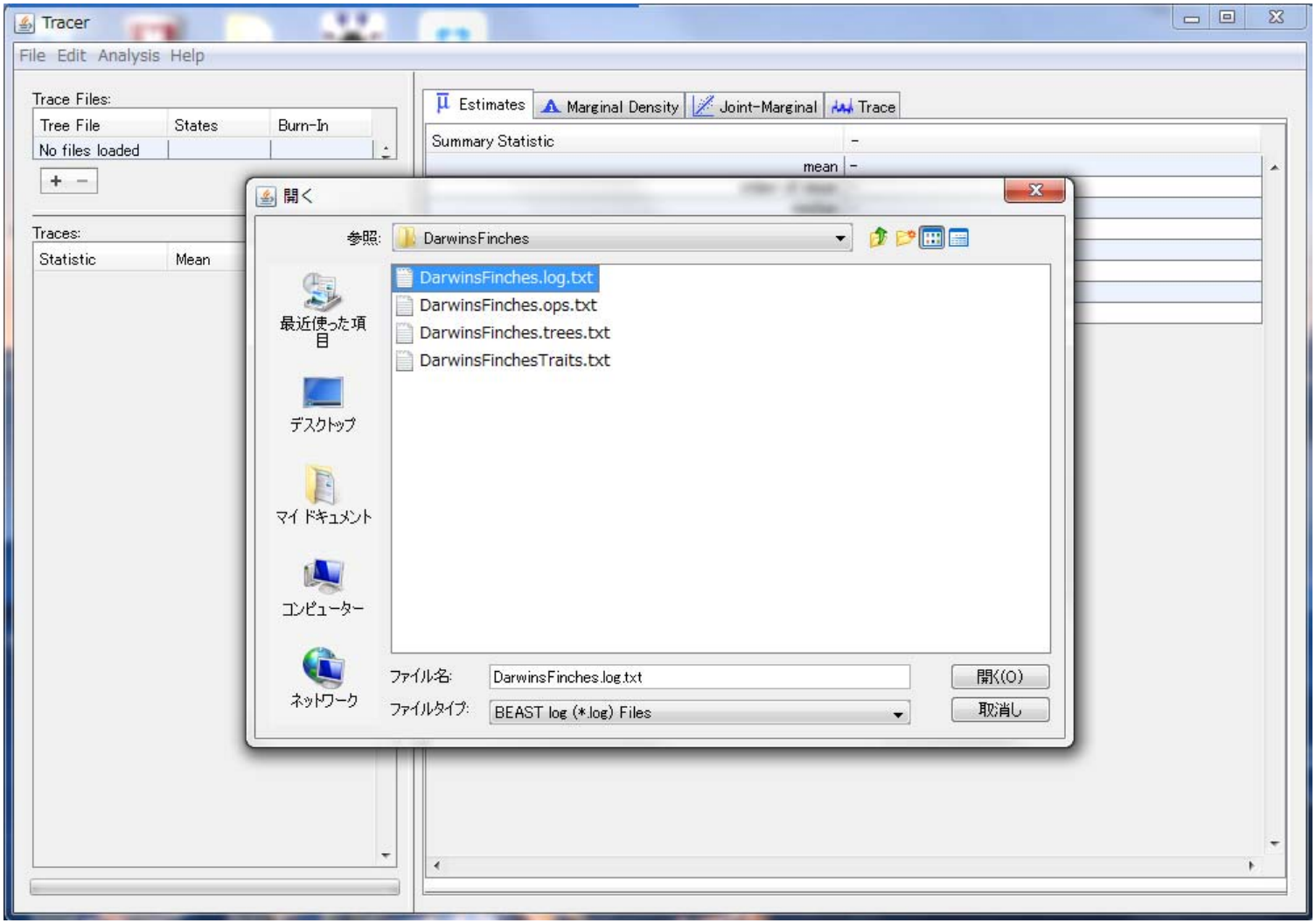
Viewing posterior distributions by Tracer

Start Tracer



Open the log file that includes the MCMC sample

[File][Import Trace File]



Posterior distribution of the log likelihood

Summary statistics are listed above the figure

Tracer

File Edit Analysis Help

Trace Files:

Tree File	States	Burn-In
DarwinsFinches.l...	10000000	1000000

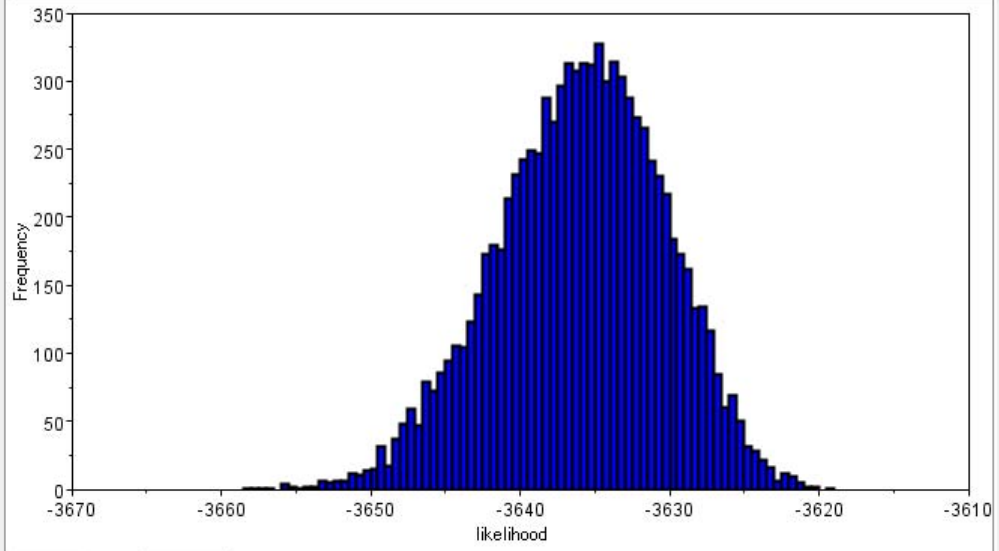
+ −

Traces:

Statistic	Mean	ESS
posterior	-3668.159	724.459
prior	-32.189	613.089
likelihood	-3635.97	1300.531
treeModel.rootHe...	1.758E-2	3727.717
birthDeath.mean...	125.775	6123.167
birthDeath.relativ...	0.386	5021.511
kappa	68.965	579.715
frequencies1	0.274	353.414
frequencies2	0.335	271.51
frequencies3	0.139	467.572
frequencies4	0.253	436.279
alpha	6.782E-2	411.714
clock.rate	1	-
rateChangeCount	1.019	1251.264
meanRate	1	7812.646
coefficientOfVari...	0.244	566.129
covariance	8.59E-2	
Finches_traits.pr...	14.202	8978.503
Finches_traits.pr...	-3.026	9001
Finches_traits.pr...	-2.389	8738.552
Finches_traits.pr...	-1.198	9001
Finches_traits.pr...	-0.682	9001
Finches_traits.pr...	-3.026	9001
Finches_traits.pr...	11.228	9001
Finches_traits.pr...	-1.221	9001
Finches_traits.pr...	0.319	8970.532
Finches_traits.pr...	-1.129	8764.045
Finches_traits.pr...	-2.389	8738.552

Estimates | Marginal Density | Joint-Marginal | Trace

Summary Statistic	
mean	-3635.9701
stderr of mean	0.1552
median	-3635.7075
geometric mean	n/a
95% HPD lower	-3646.7424
95% HPD upper	-3625.1663
auto-correlation time (ACT)	6921.0179
effective sample size (ESS)	1300.5312



Axes... Bins: 100

Check the effective sample sizes

Tracer

File Edit Analysis Help

Trace Files:

Tree File	States	Burn-In
DarwinsFinches.l...	10000000	1000000

Traces:

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Estimates | Marginal Density | Joint-Marginal | Trace

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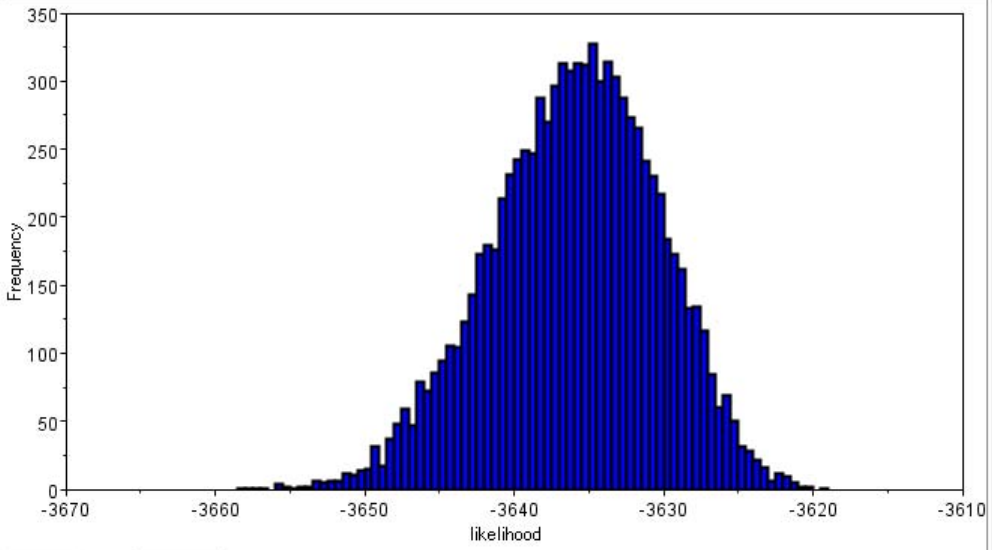
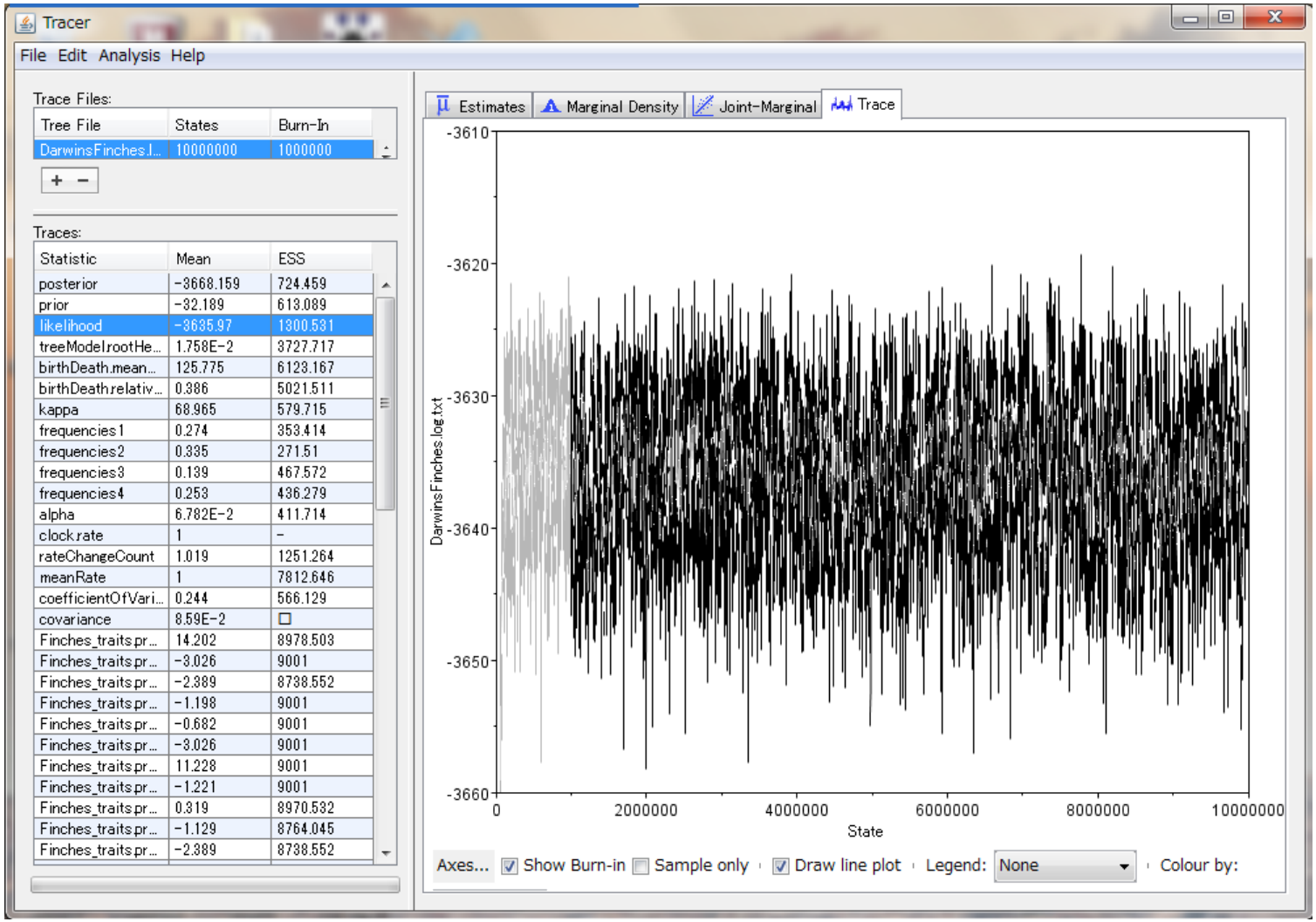
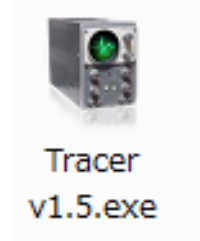


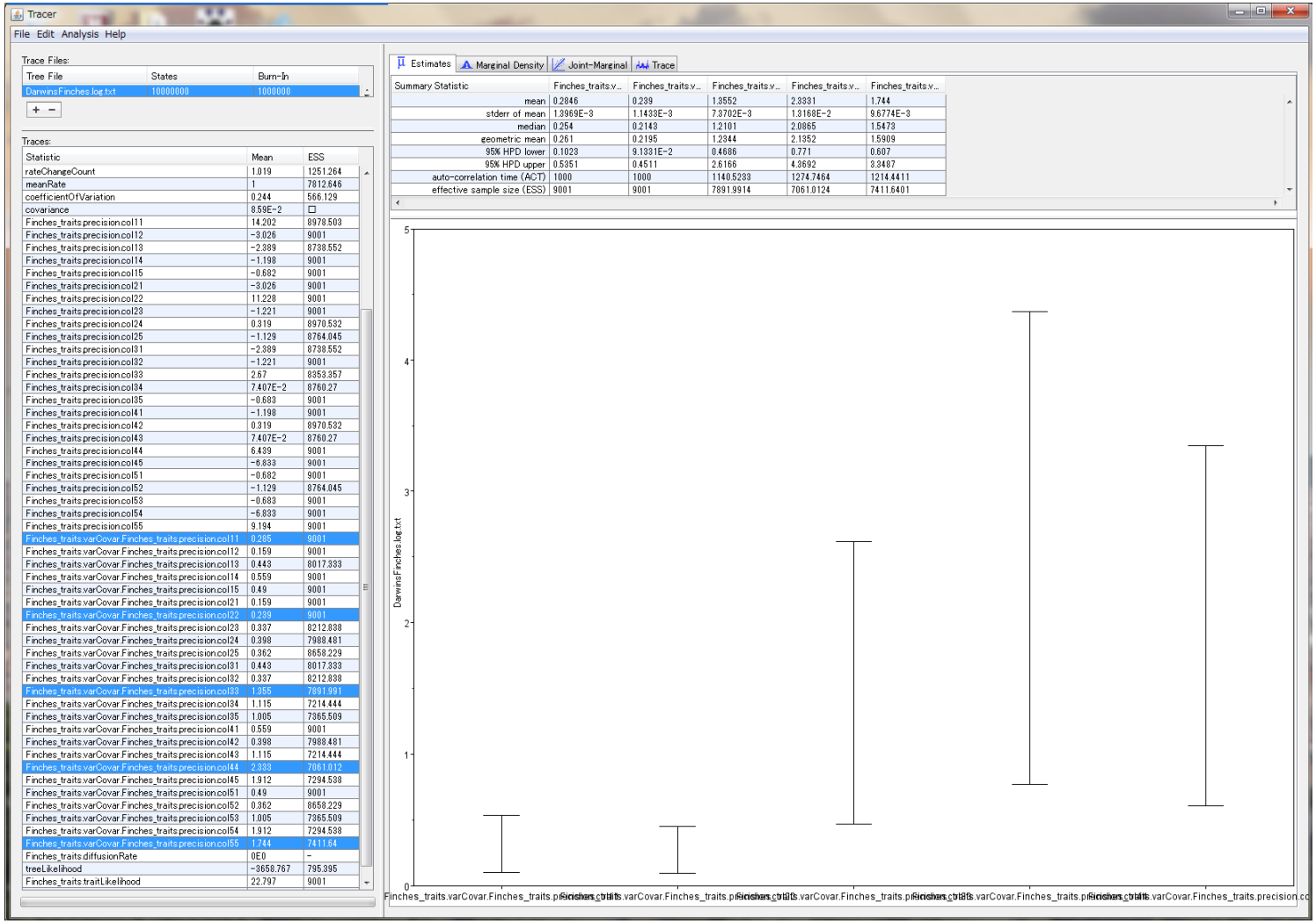
Axes... Bins: 100

Trace the history to check if MCMC is well mixed



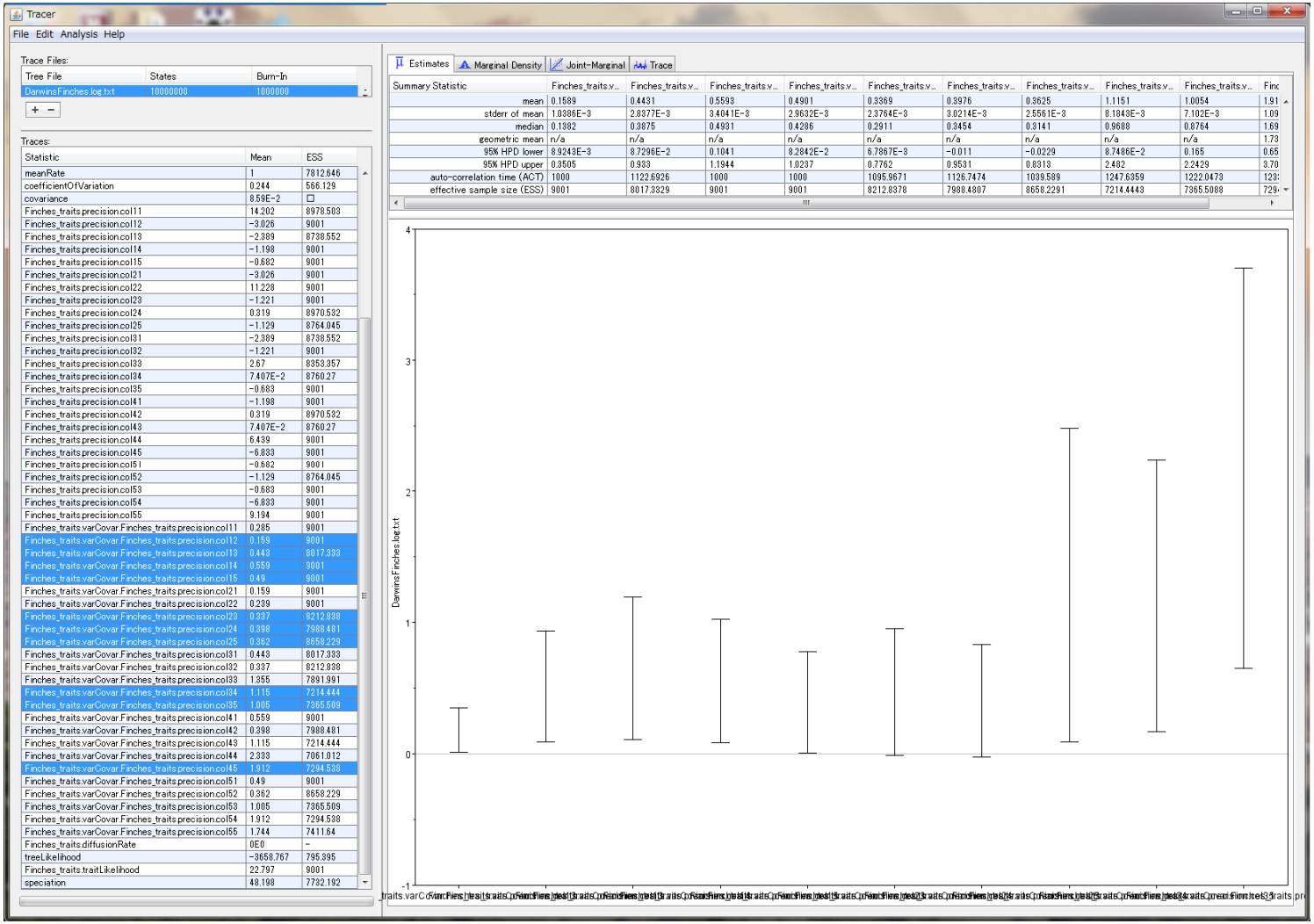
The posterior distributions of the rate-variances





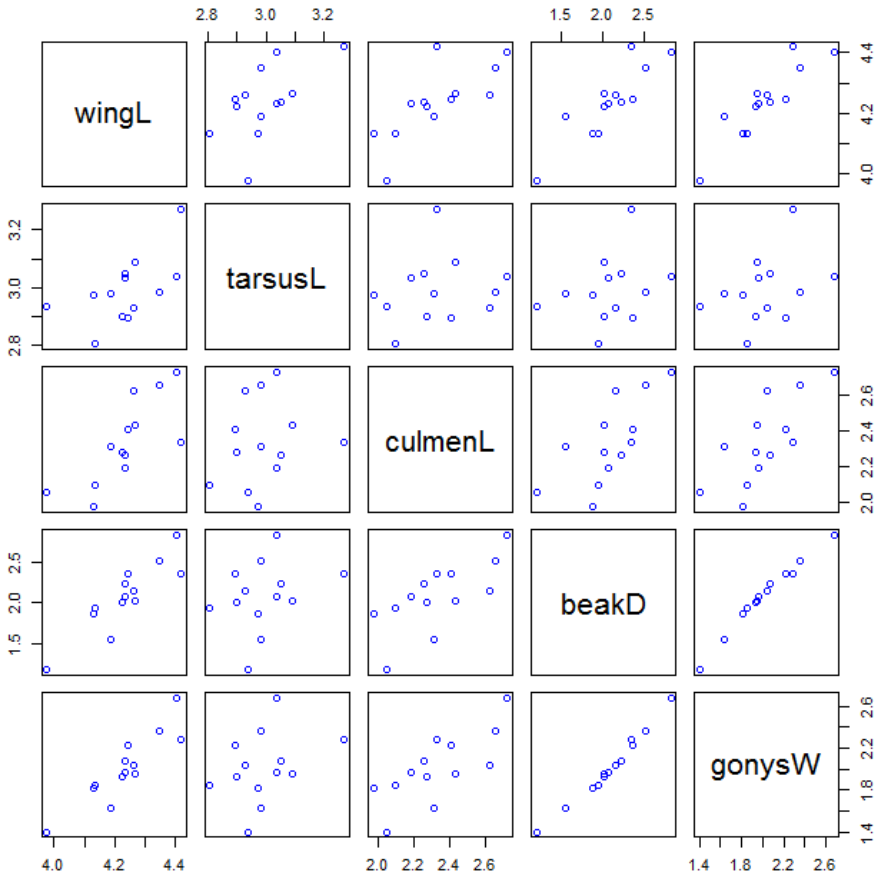
wingL (w) tarsusL (t) culmenL (c) beakD (b) gonysW (g)

The posterior distributions of the rate-covariances



w-t w-c w-b w-g t-c t-b t-g c-b c-g b-g

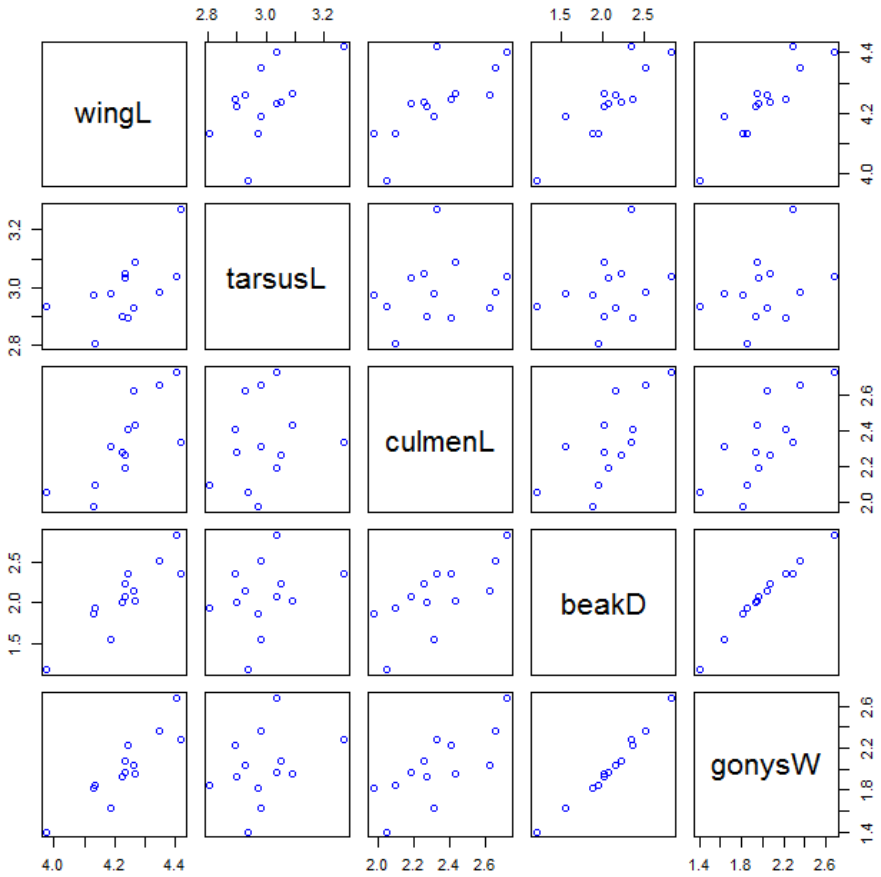
Traits data



Correlation between traits

	wingL	tarsusL	culmenL	beakD	gonysW
wingL	1.000	0.593	0.757	0.881	0.899
tarsusL	0.593	1.000	0.192	0.298	0.354
culmenL	0.757	0.192	1.000	0.714	0.752
beakD	0.881	0.298	0.714	1.000	0.988
gonysW	0.899	0.354	0.752	0.988	1.000

Rate-correlations and correlation in the traits data



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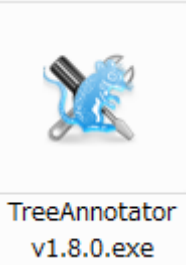
beakD	0.881	0.298	0.714	1.000	0.988
gonysW	0.899	0.354	0.752	0.988	1.000

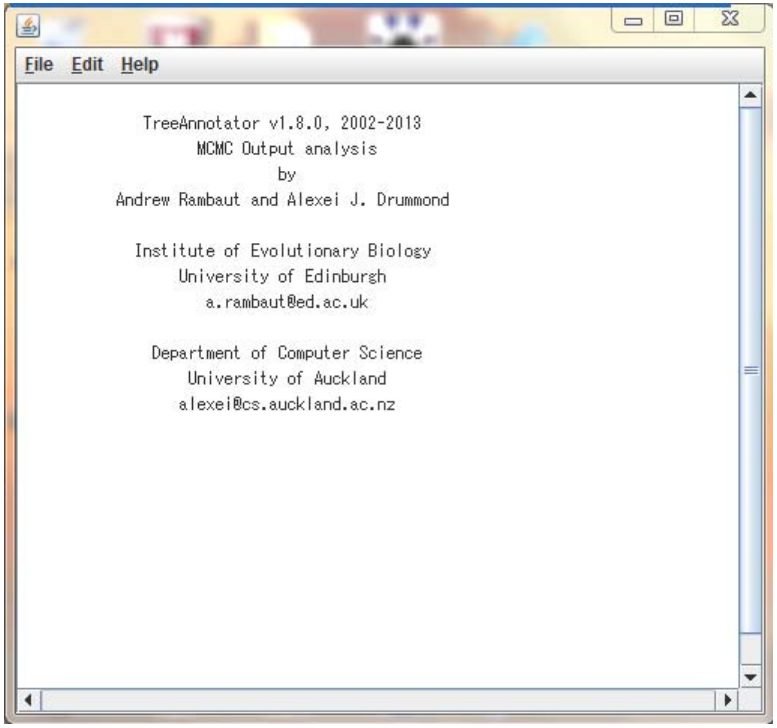
Correlation between the rates

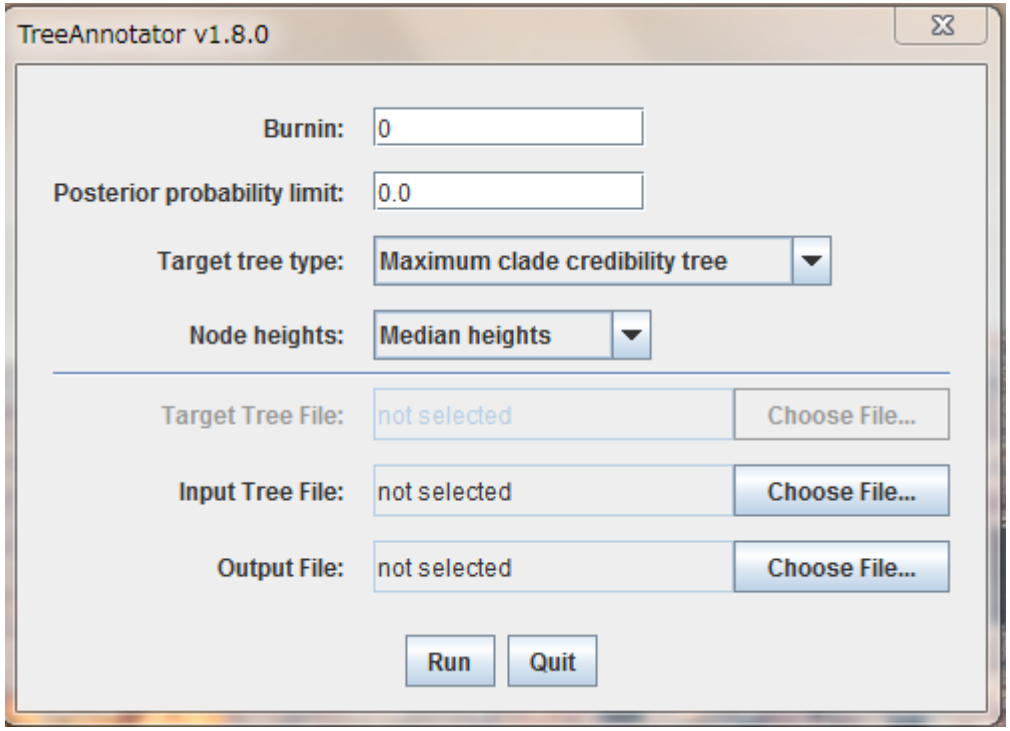
	wingL	tarsusL	culmenL	beakD	gonysW
wingL	1.000	0.593	0.697	0.671	0.681
tarsusL	0.593	1.000	0.575	0.518	0.546
culmenL	0.697	0.575	1.000	0.611	0.638
beakD	0.671	0.518	0.611	1.000	0.943
gonysW	0.681	0.546	0.638	0.943	1.000


Summarize the
MCMC trees
by TreeAnnotator

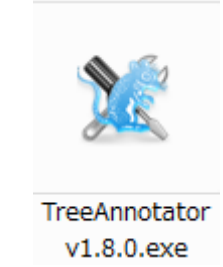
Start TreeAnnotator

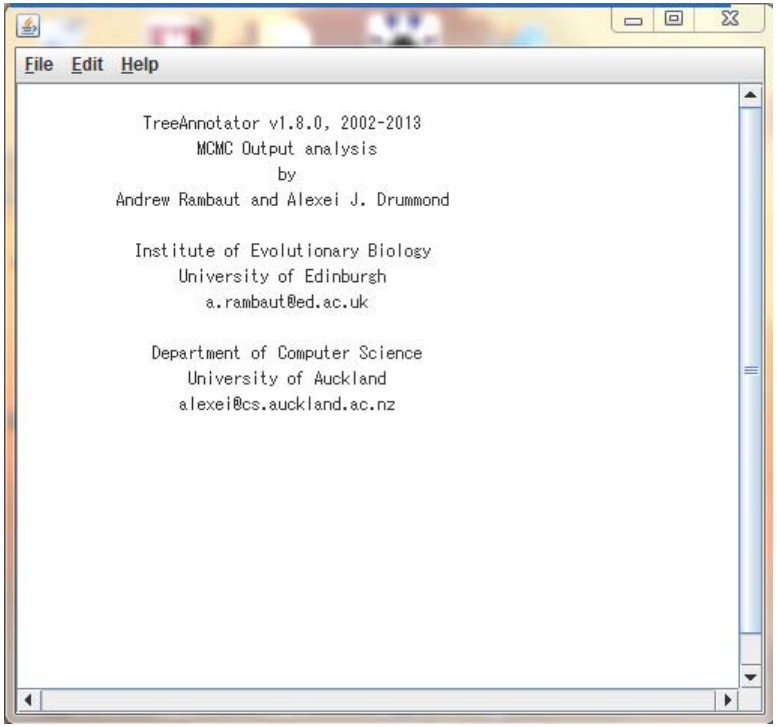


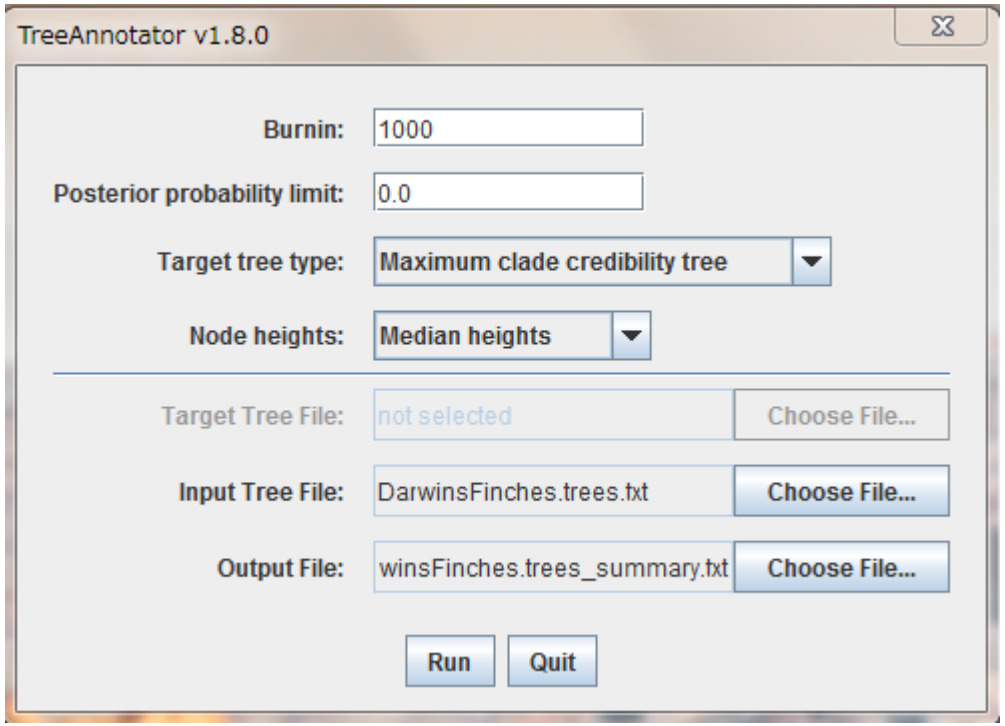




Specify bur-in and input/output files

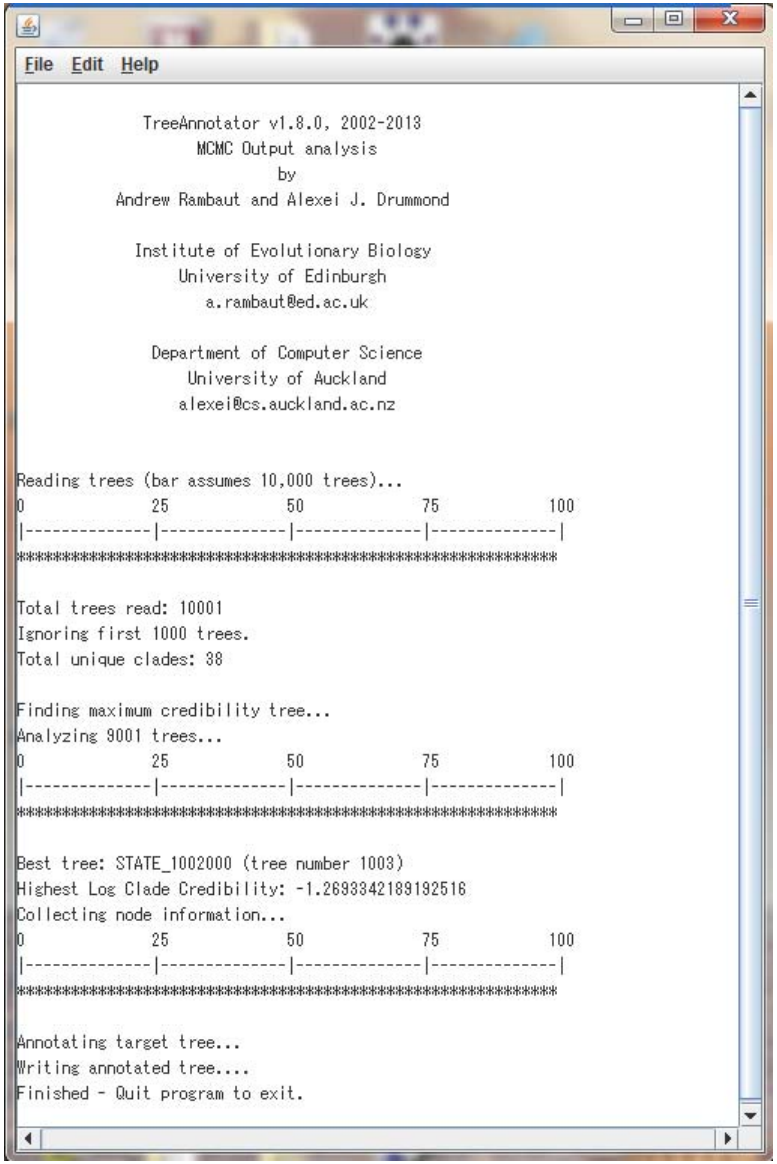


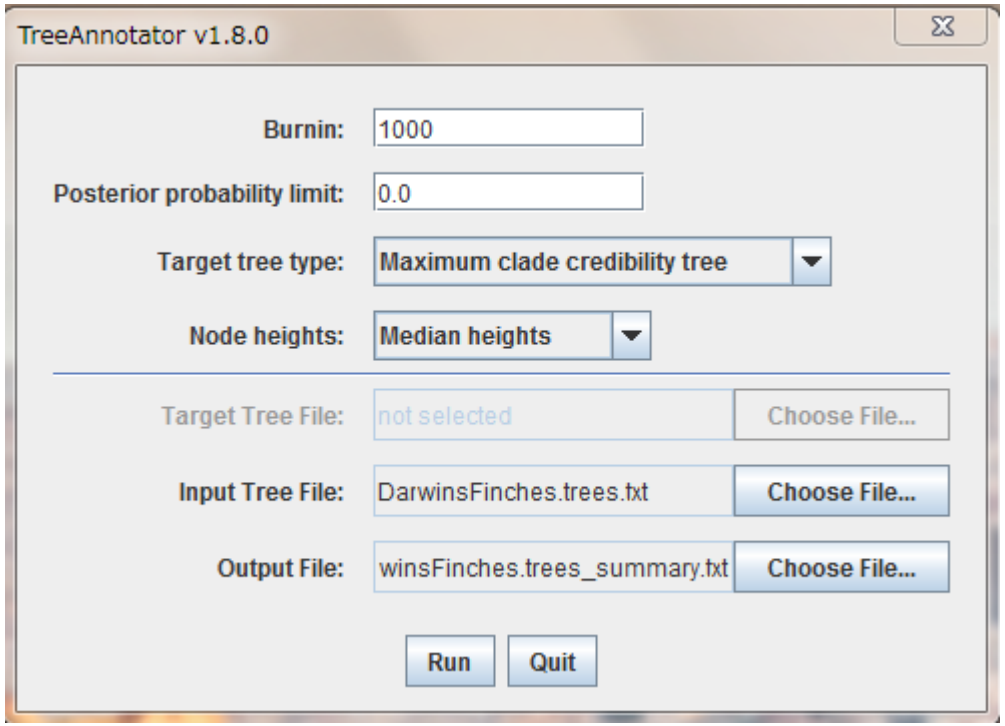




Burn-in: 1000
Input file: DarwinsFinches.trees.txt
Output file: DarwinsFinches.trees_summary.txt

Run

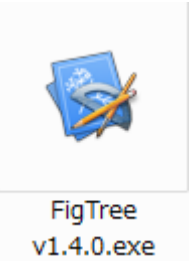


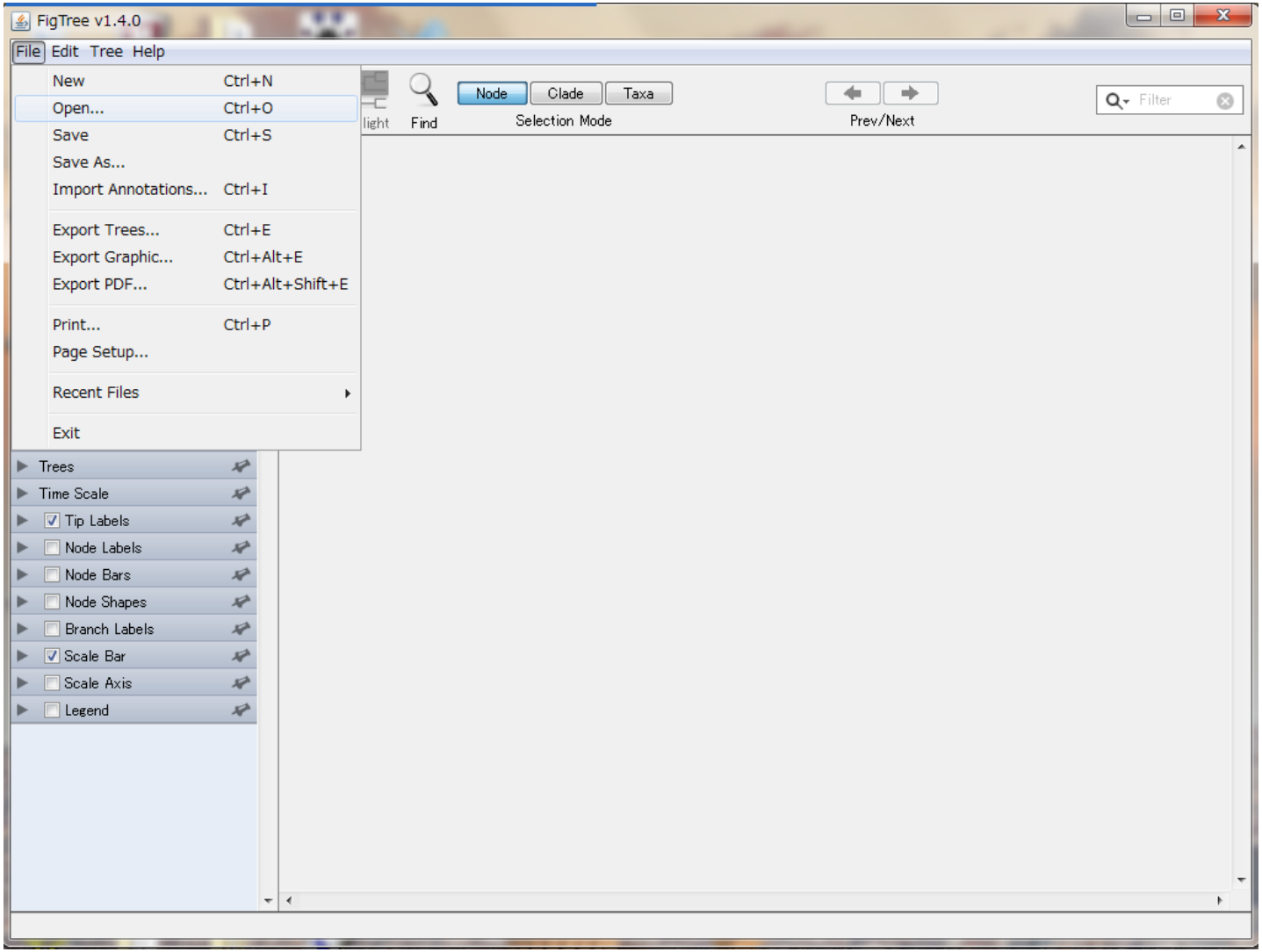


Done, immediately.

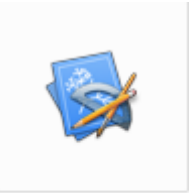

Drawing
summarized tree
by FigTree

FigTree: Open DarwinsFinches.trees_summary.txt

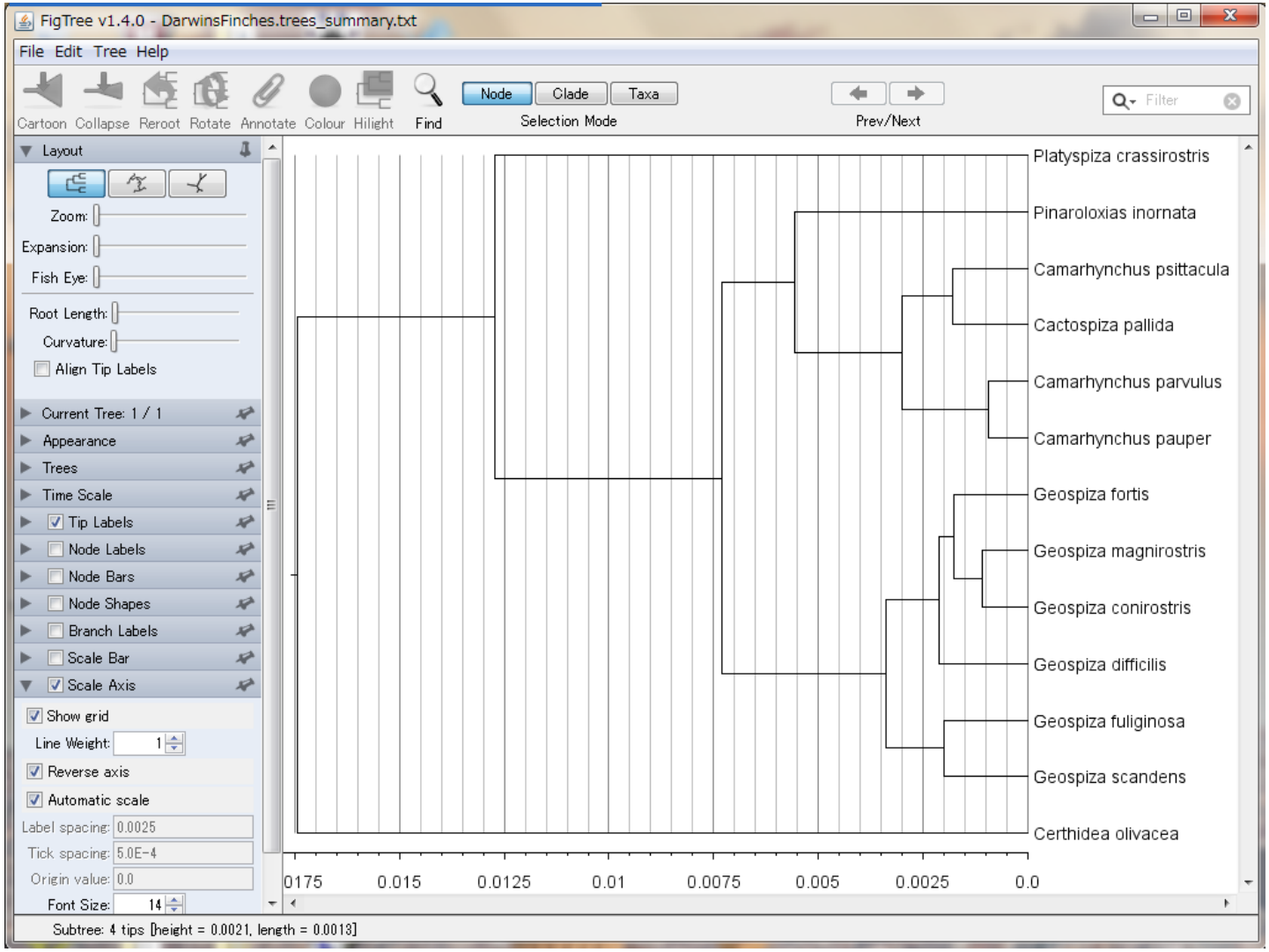




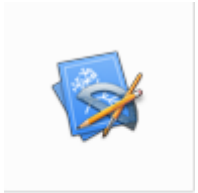
Specify the parameters of Tip labels and scale axis



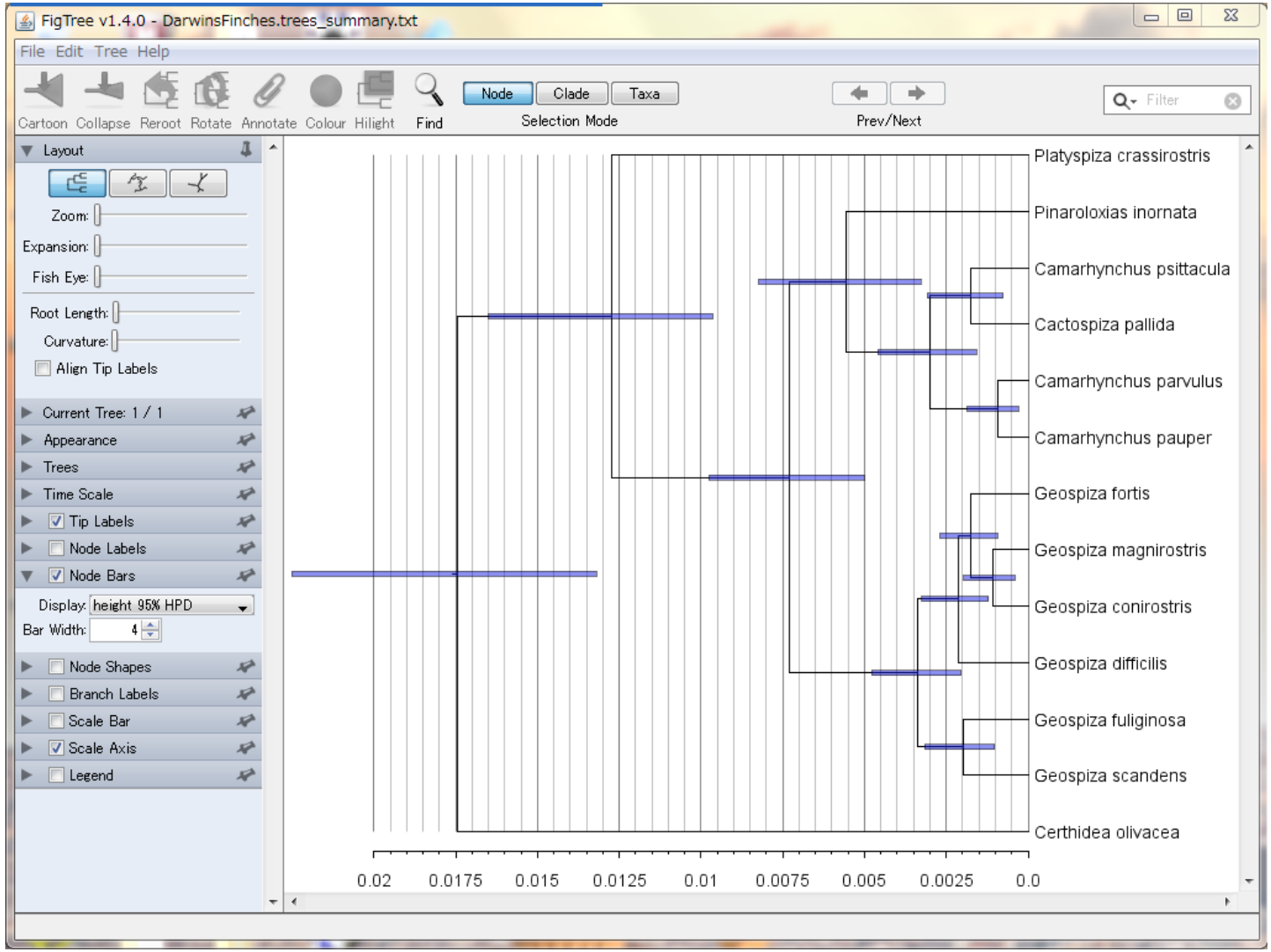
Reverse the axis in [Scale axis]



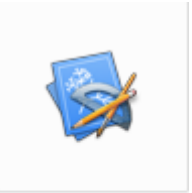
Node Bars: the credibility intervals of divergence times



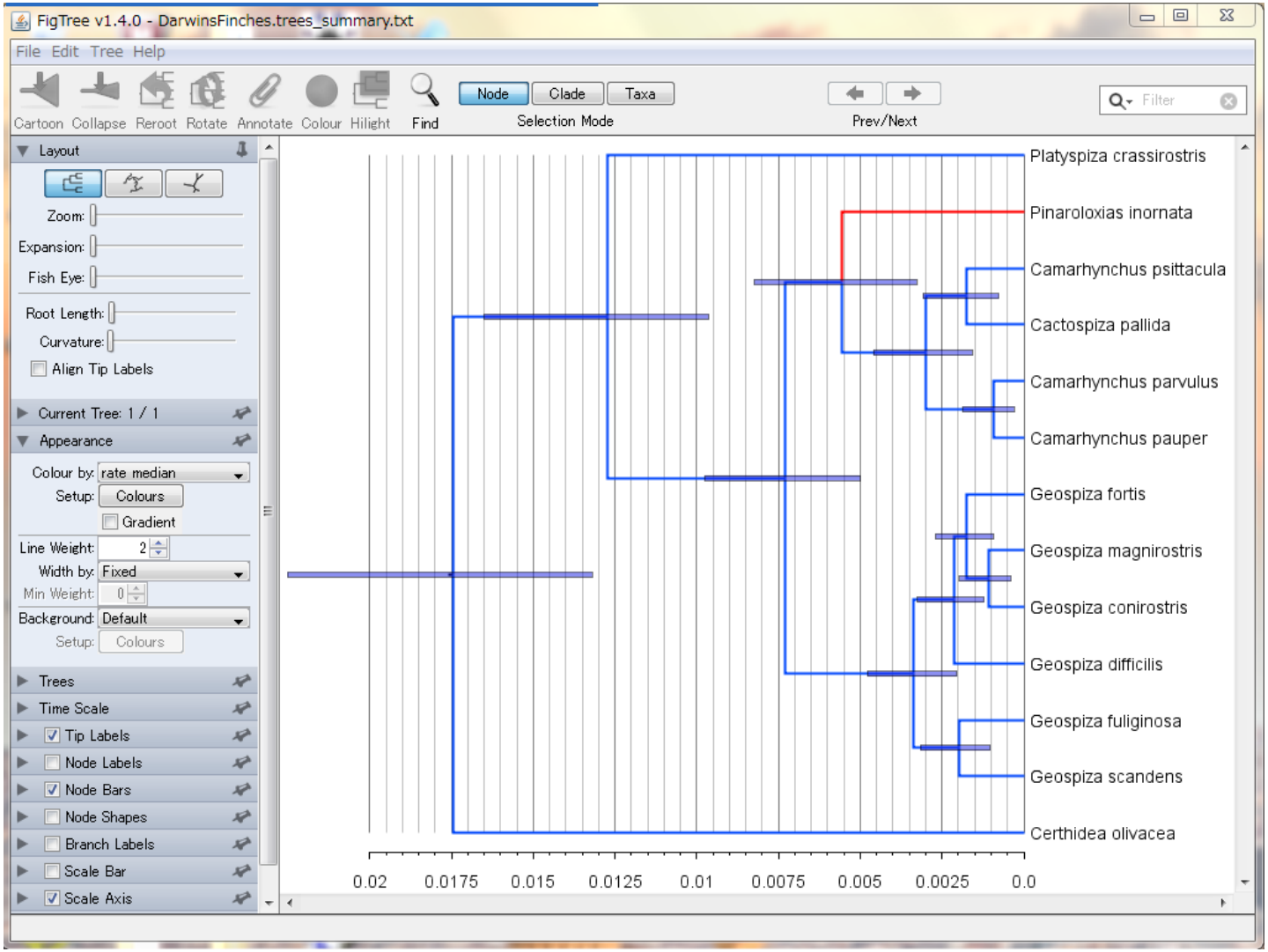
Display: height 95% HPD



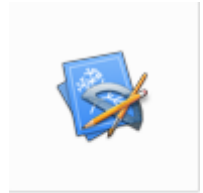
Appearance: colored branches for evolutionary rates



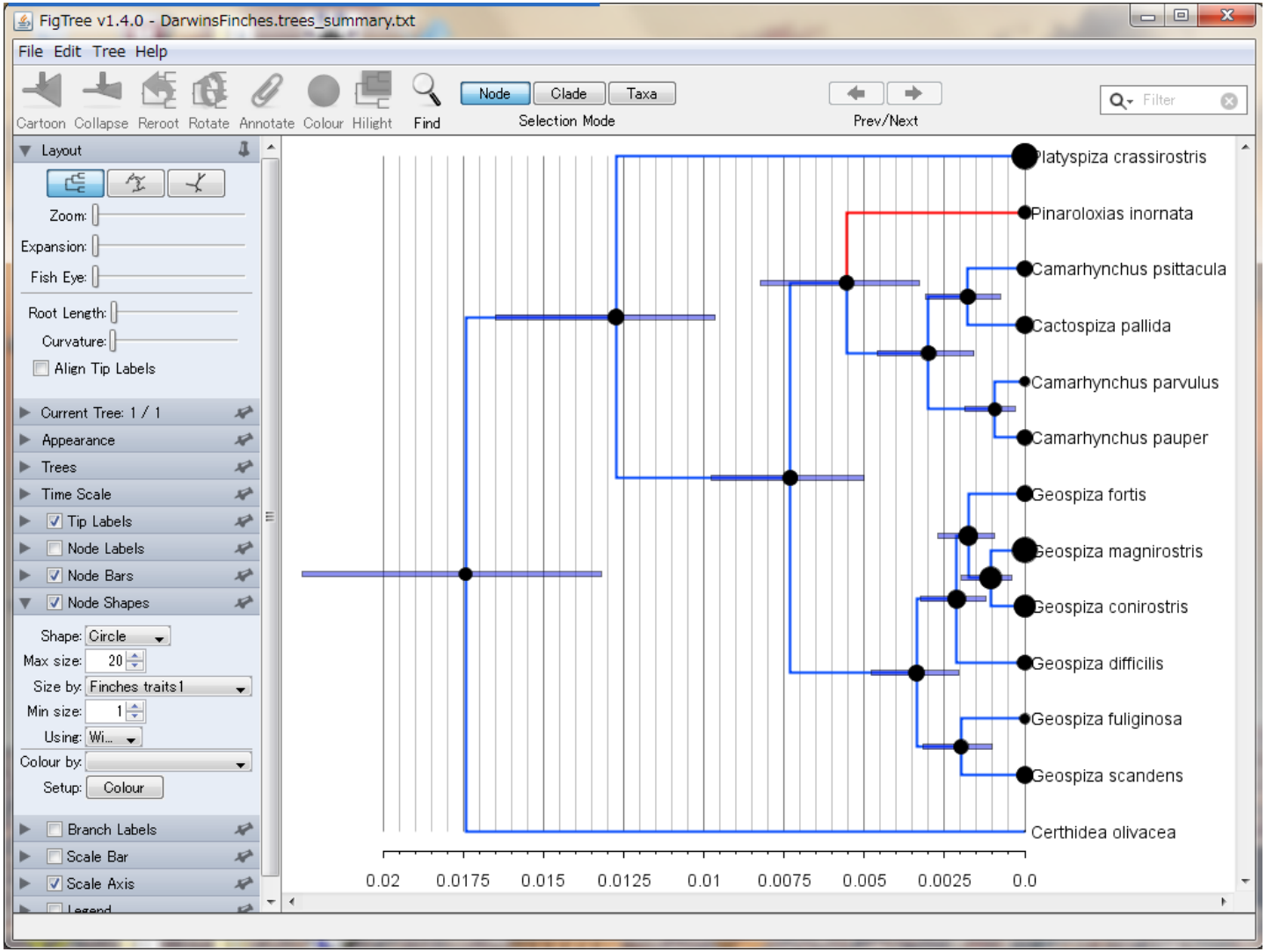
Colour by: rate_median, set blue/red in RGB as lower/upper limit



Node shapes for the values of the traits



Size by: Finches_traits 1 (wingL), Max_size: 20, Min_size: 1



Remark on the analysis of continuous traits with BEAST

1. BEAST version 2 does not analyze the continuous traits at this moment. It treats geographic traits for the phylogeographic analysis.

2. BEAST version 1.8.3 has some problem BEAUti for morphological traits specification.

3. Please use BEAST version 1.8.0 for this analysis. Previous versions are available from https://code.google.com/archive/p/beast-mcmc/downloads .

4. The following softwares are also recommended:
   - BayesTraits
   - Coevol (runs on linux or macOSX)

Homework 4

Please analyze the data of primates or Darwin's finch again, and estimate the evolutionary history of the traits and the pattern of dependence.

Please send the word file / pdf file named **agri4_name.doc** /**agri4_name.pdf** to:

Prof. Masami Hasegawa (masamihase@gmail.com) **with cc to:**
Hirohisa Kishino (kishino@lbm.ab.a.u-tokyo.ac.jp).

Here, "name" should be replaced by your name.
Deadline: 11 June 2017 (Sunday)