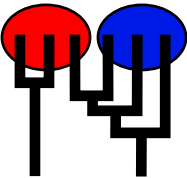


# test snp data

POPULATION SIZE, MIGRATION, DIVERGENCE, ASSIGNMENT, HISTORY  
Bayesian inference using the structured coalescent  
Migrate-n version 5.0.7 [May-01-2025]  
Program started at Sat May 3 12:24:21 2025  
Program finished at Sat May 3 12:25:39 2025 [Runtime:0000:00:01:18]



## Options

Inheritance multipliers in use for Thetas:  
All loci use an inheritance multiplier of 1.0  
Random number seed: (with internal timer) 3600804701  
Start parameters:

Theta values were generated Using a percent value of the prior  
M values were generated Using a percent value of the prior

Connection matrix:  
m = average (average over a group of Thetas or M,  
s = symmetric migration M, S = symmetric 4Nm,  
0 = zero, and not estimated,  
\* = migration free to vary, Thetas are on diagonal  
d = row population split off column population, D = split and then migration

Population	1	2
1 pop1	*	*
2 pop2	*	*

Order of parameters:		
1	$\Theta_1$	<displayed>
2	$\Theta_2$	<displayed>
3	$M_{2 \rightarrow 1}$	<displayed>
4	$M_{1 \rightarrow 2}$	<displayed>

Mutation rate among loci:

Mutation rate is constant for all loci

Analysis strategy:

Bayesian inference

-Population size estimation:

Exponential Distribution

-Geneflow estimation:

Exponential Distribution

Proposal distributions for parameter

Parameter	Proposal
Theta	Metropolis sampling
M	Metropolis sampling
Genealogy	Metropolis-Hastings

Prior distribution for parameter

Parameter			Prior	Minimum	Mean*	Maximum	Delta	Bins	UpdateFreq	
1	Theta	*	*	Uniform	0.000000	0.050	0.100	0.010000	1500	0.12500
2	Theta	*	*	Uniform	0.000000	0.050	0.100	0.010000	1500	0.12500
3	M	*	*	Uniform	0.000000	500.0	1000.	100.00000	1500	0.12500
4	M	*	*	Uniform	0.000000	500.0	1000.	100.00000	1500	0.12500

[\* \* means priors were set globally]

Posterior distribution:

Parameter values were collected using MCMC, these values

were then used to generate the posterior histograms using KERNEL SMOOTHING (window=41)

and subsequent SAVITZKY-GOLAY SMOOTHING (window=41) for combination over loci

Markov chain settings:

Long chain

Number of chains	1
Recorded steps [a]	10000
Increment (record every x step [b])	100
Number of concurrent chains (replicates) [c]	1
Visited (sampled) parameter values [a*b*c]	1000000
Number of discard trees per replicate (burn-in * b)	100000

Multiple Markov chains:

Static heating scheme

4 chains with temperatures  
1000000.00 3.00 1.50 1.00  
Swapping interval is 1

Print options:

Data file:

infile.snp  
parmfile.snp

Haplotyping is turned on:

NO

Output file:	outfile_snp
Posterior distribution raw histogram file:	bayesfile
Raw data from the MCMC run:	bayesallfile.txt
Print data:	No
Print genealogies [only some for some data type]:	None

## *Data summary*

Data file: infile.snp  
 Datatype: Haplotype data  
 Number of loci: 3

### Mutationmodel:

Locus	Sublocus	Mutationmodel	Mutationmodel parameters
1	1	Jukes-Cantor	[Basefreq: =0.25]
2	1	Jukes-Cantor	[Basefreq: =0.25]
3	1	Jukes-Cantor	[Basefreq: =0.25]

### Sites per locus

Locus	Sites
1	1
2	1
3	1

### Site rate variation and probabilities:

Locus	Sublocus	Region type	Rate of change	Probability	Patch size
1	1	1	1.000	1.000	1.000
2	1	1	1.000	1.000	1.000
3	1	1	1.000	1.000	1.000

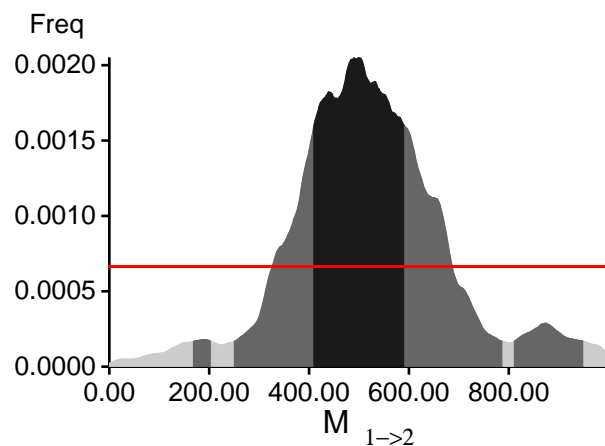
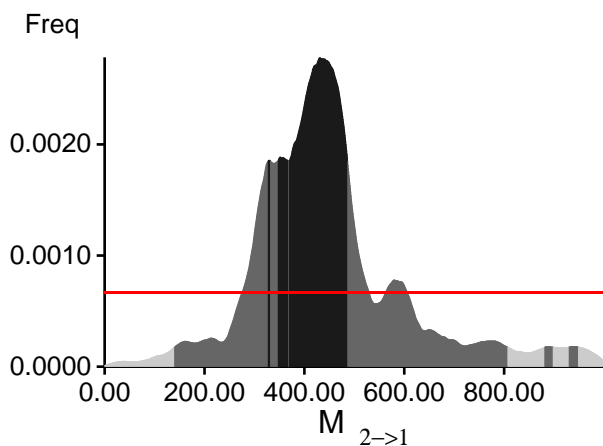
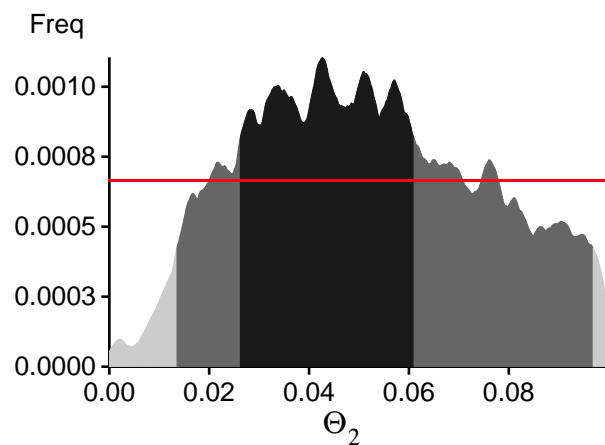
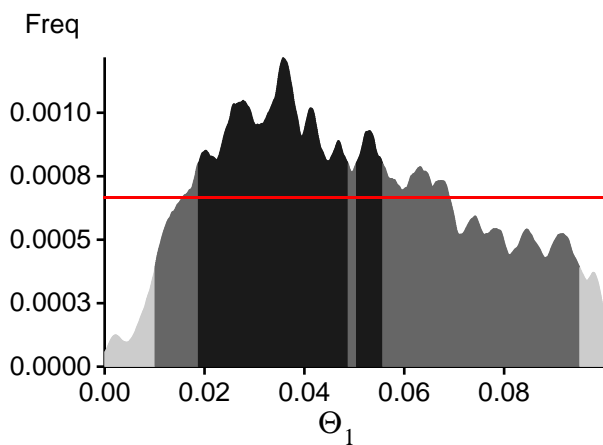
Population	Locus	Gene copies data	(missing)
1 pop1	1	2	
	2	2	
	3	2	
2 pop2	1	3	
	2	3	
	3	3	
Total of all populations	1	5	(0)
	2	5	(0)
	3	5	(0)

## *Bayesian Analysis: Posterior distribution table*

Locus	Parameter	2.5%	25.0%	Mode	75.0%	97.5%	Median	Mean
1	$\Theta_1$	0.01147	0.01907	0.02597	0.03733	0.09333	0.05063	0.05174
1	$\Theta_2$	0.01300	0.03140	0.04303	0.06333	0.09887	0.05257	0.05329
1	$M_{2 \rightarrow 1}$	142.000	274.000	613.000	644.667	852.667	507.667	512.906
1	$M_{1 \rightarrow 2}$	153.333	316.667	509.667	754.000	954.667	533.667	535.689
2	$\Theta_1$	0.01153	0.01607	0.03657	0.07033	0.09553	0.05063	0.05178
2	$\Theta_2$	0.01260	0.04000	0.05117	0.06227	0.09880	0.05377	0.05404
2	$M_{2 \rightarrow 1}$	266.000	416.000	449.000	462.667	526.000	424.333	441.604
2	$M_{1 \rightarrow 2}$	279.333	404.000	488.333	552.667	748.667	505.667	509.804
3	$\Theta_1$	0.00580	0.02680	0.03577	0.04167	0.07673	0.04757	0.04901
3	$\Theta_2$	0.00553	0.01127	0.03130	0.06240	0.09220	0.04783	0.04918
3	$M_{2 \rightarrow 1}$	138.000	412.667	430.333	539.333	990.667	545.000	544.431
3	$M_{1 \rightarrow 2}$	140.667	460.667	549.000	672.667	987.333	533.000	535.324
All	$\Theta_1$	0.01000	0.01867	0.03577	0.04873	0.09513	0.04590	0.04871
All	$\Theta_2$	0.01347	0.02613	0.04263	0.06100	0.09687	0.05017	0.05151
All	$M_{2 \rightarrow 1}$	139.333	368.667	431.000	486.667	807.333	430.333	450.538
All	$M_{1 \rightarrow 2}$	249.333	408.667	489.667	591.333	788.000	512.333	520.505

### Citation suggestions:

- Beerli P., 2006. Comparison of Bayesian and maximum-likelihood inference of population genetic parameters. *Bioinformatics* 22:341-345
- Beerli, P., H. Ashki, S. Mashayekhi, and M. Palczewski, 2022. Population divergence time estimation using individual lineage label switching. *G3 Genes & Genomes & Genetics*, 12(4), 02 2022.
- Beerli P., 2009. How to use MIGRATE or why are Markov chain Monte Carlo programs difficult to use? In *Population Genetics for Animal Conservation*, G. Bertorelle, M. W. Bruford, H. C. Hauffe, A. Rizzoli, and C. Vernesi, eds., vol. 17 of *Conservation Biology*, Cambridge University Press, Cambridge UK, pp. 42-79.
- Beerli, P., S. Mashayekhi, M. Sadeghi, M. Khodaei, and K. Shaw, 2019. Population genetic inference with migrate. *Current Protocols in Bioinformatics*, 68(1):e87.

*Bayesian Analysis: Posterior distribution over all loci*

## *Log-Probability of the data given the model (marginal likelihood)*

Use this value for Bayes factor calculations:

$BF = \text{Exp}[\ln(\text{Prob}(D \mid \text{thisModel})) - \ln(\text{Prob}(D \mid \text{otherModel}))]$

or as  $LBF = 2 (\ln(\text{Prob}(D \mid \text{thisModel})) - \ln(\text{Prob}(D \mid \text{otherModel})))$

shows the support for thisModel]

Locus	TI(1a)	BTI(1b)	HS(3)
1	-5.14	-5.03	-5.12
2	-4.90	-4.78	-4.82
3	-0.08	-0.08	-0.08
All	-28.63	-28.40	-28.54

(1a) TI: Thermodynamic integration:  $\log(\text{Prob}(D \mid \text{Model}))$ : Good approximation with many temperatures

(1b) BTI: Bezier-approximated Thermodynamic integration: when using few temperatures USE THIS!

(3) HS: Harmonic mean approximation: Overestimates the marginal likelihood, poor variance

[Scaling factor = -18.510264]

Citation suggestions:

Beerli P. and M. Palczewski, 2010. Unified framework to evaluate panmixia and migration direction among multiple sampling locations, *Genetics*, 185: 313-326.

Palczewski M. and P. Beerli, 2014. Population model comparison using multi-locus datasets.

In M.-H. Chen, L. Kuo, and P. O. Lewis, editors, *Bayesian Phylogenetics: Methods, Algorithms, and Applications*, pages 187-200. CRC Press, 2014.

*Acceptance ratios for all parameters and the genealogies*

Parameter	Accepted changes	Ratio
$\Theta_1$	270650/374542	0.72262
$\Theta_2$	275917/375196	0.73539
$M_{2 \rightarrow 1}$	224288/374277	0.59926
$M_{1 \rightarrow 2}$	223110/376405	0.59274
Genealogies	1212161/1499580	0.80833



## *MCMC-Autocorrelation and Effective MCMC Sample Size*

Parameter	Autocorrelation	Effective Sampe Size
$\Theta_1$	0.10178	24464.56
$\Theta_2$	0.08849	25142.86
$M_{2 \rightarrow 1}$	0.69798	5887.04
$M_{1 \rightarrow 2}$	0.69758	5852.71
Genealogies	0.10178	24464.56

## *Average temperatures during the run*

Chain	Temperatures
-------	--------------

1	1.00000
2	0.66667
3	0.33333
4	0.00000

## *Potential Problems*

This section reports potential problems with your run, but such reporting is often not very accurate. With many parameters in a multilocus analysis, it is common that some parameters for some loci will not be informative. These parameters then trigger suggestions to increase the prior range that are not sensible. Do not blindly follow the suggestions given. If some parameters are flagged, inspect the tables carefully and judge whether an action is required. Suppose you run a Bayesian inference with sequence data for macroscopic species. In that case, there is rarely the need to increase the prior for Theta beyond 0.1. If you use microsatellites data, it is rather common that your prior distribution for Theta should have a range from 0.0 to 100 or more. With many populations ( $>3$ ), it is also very common that some migration routes are estimated poorly because the data contains little or no information for that route. Increasing the prior range will not help in such situations, but reducing the number of parameters may help.

No warning was recorded during the run