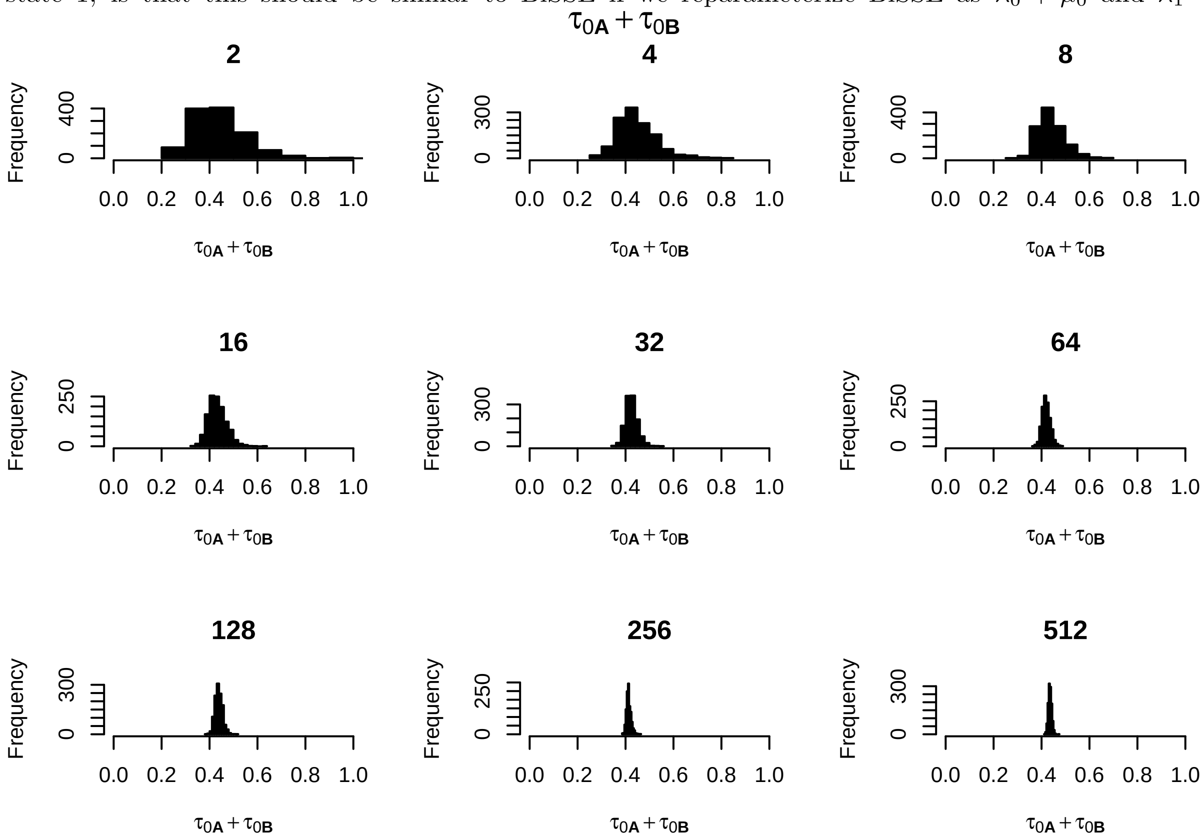
HiSSEChecks

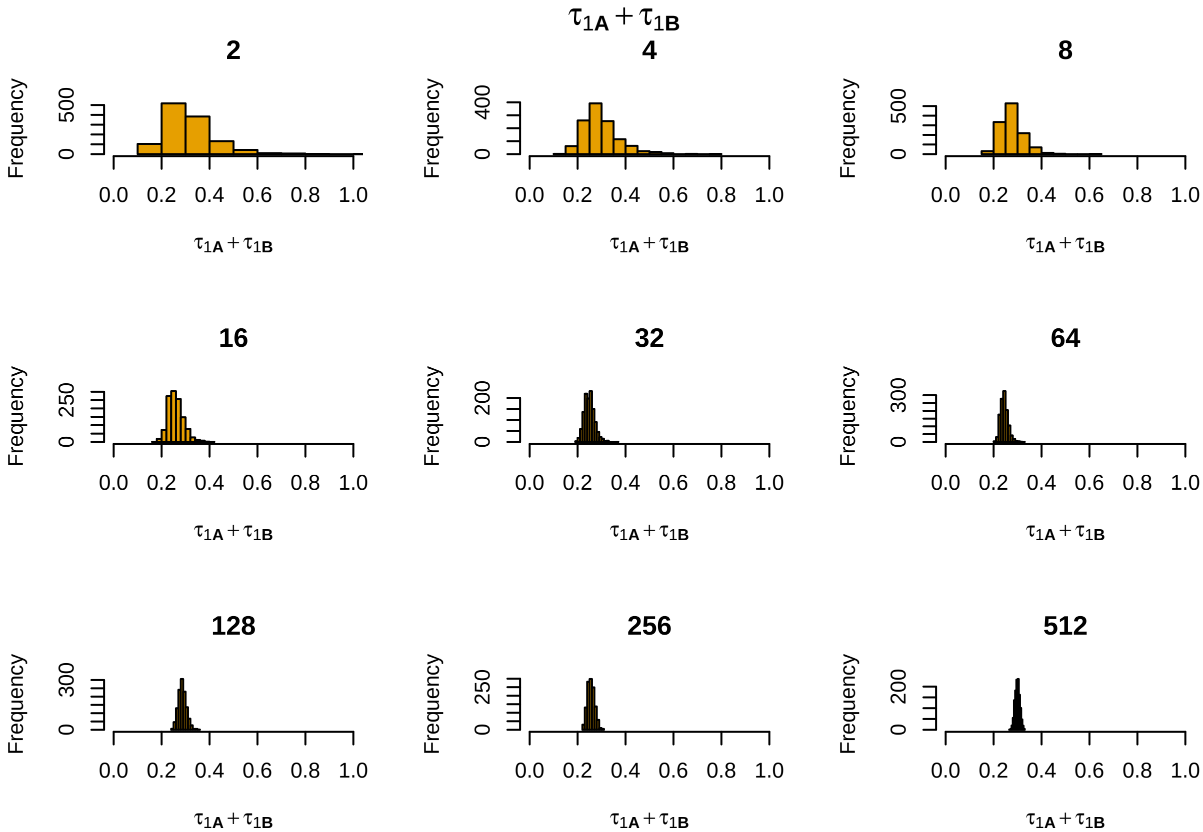
(I) Parameter combinations -

A) Turnover rates

1. Checks for addition $\tau_{0A} + \tau_{0B}$ AND $\tau_{1A} + \tau_{1B}$

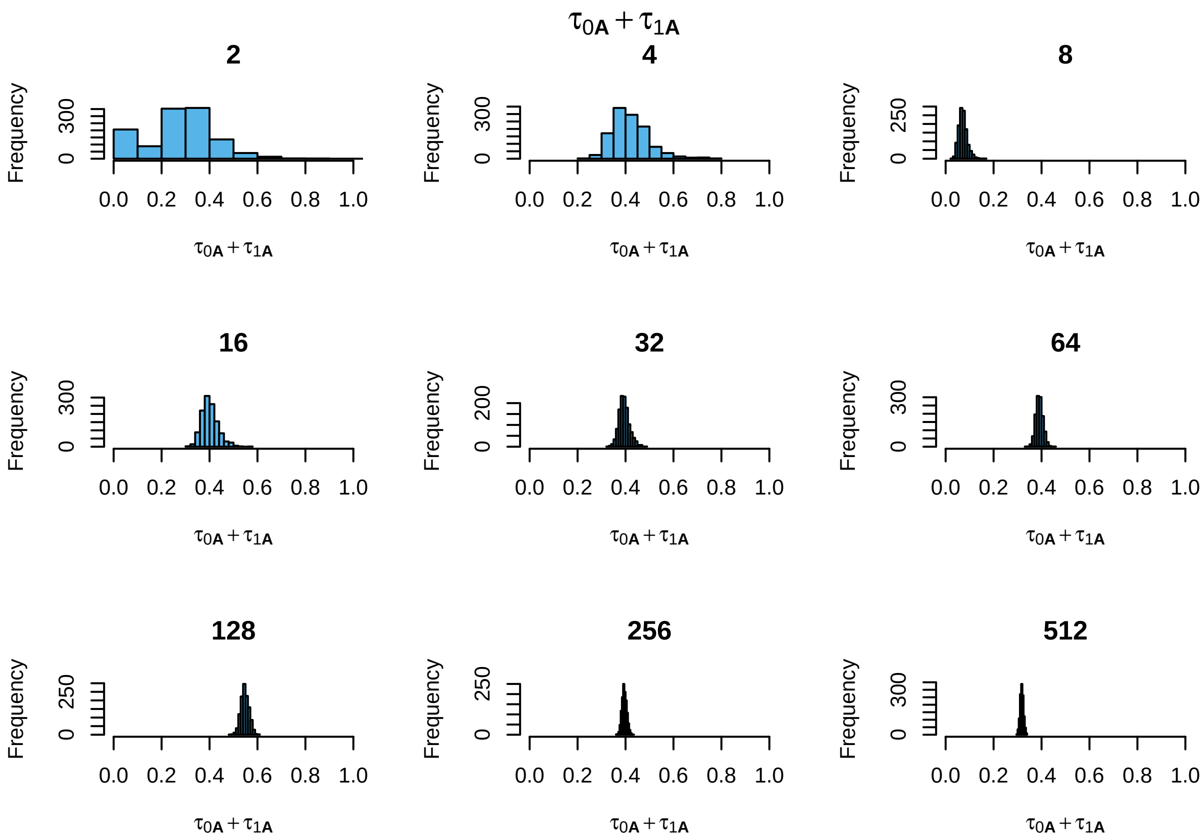
My reason behind adding turnover rates for state 0A and 0B into state 0 and state 1A and 1B to state 1, is that this should be similar to BiSSE if we reparameterize BiSSE as $\lambda_0 + \mu_0$ and $\lambda_1 + \mu_1$.



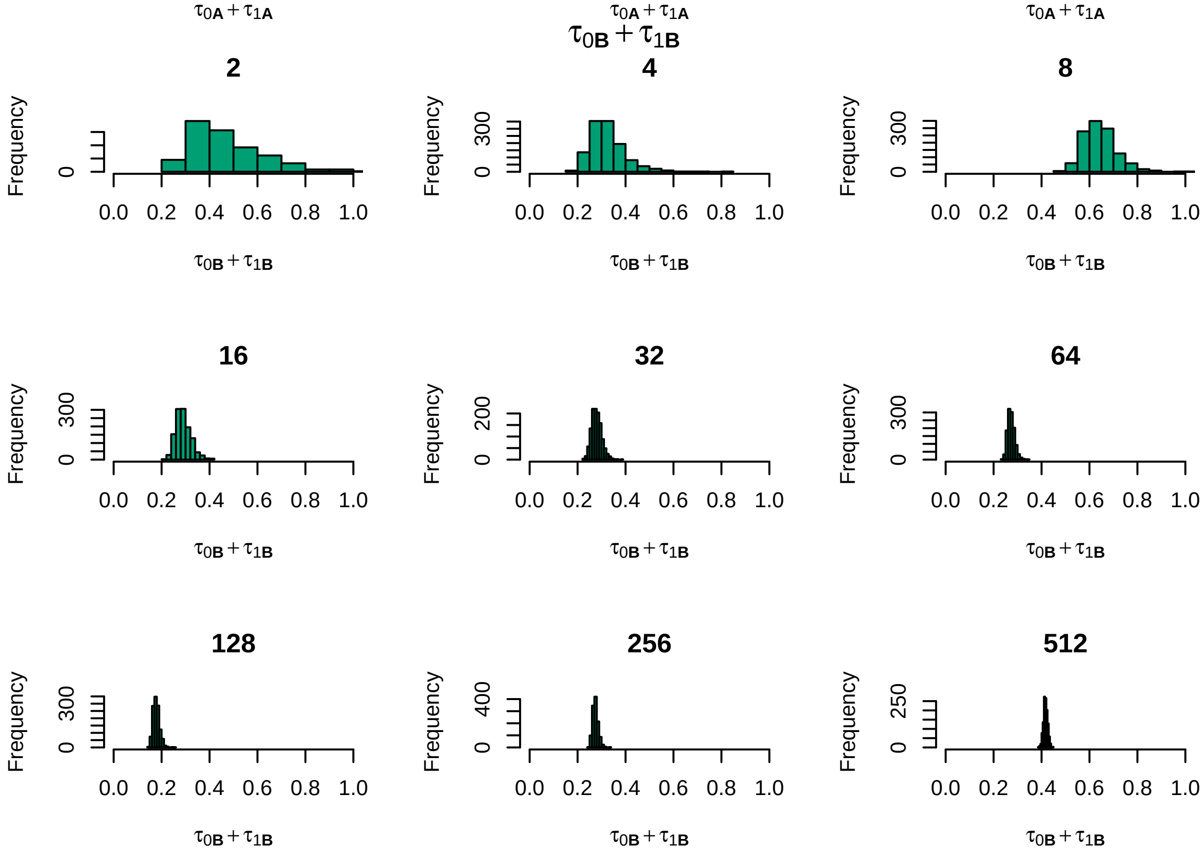


2. Checks for addition $\tau_{0A} + \tau_{1A}$ AND $\tau_{0B} + \tau_{1B}$

Here I am checking if hidden states have a signal in turnover rates i.e. if the two rate classes A and B can also be combined. Here state A is represented by the sum $\tau_{0A} + \tau_{1A}$ and state B is represented by the sum $\tau_{0B} + \tau_{1B}$.



$\tau_{0A} + \tau_{1A}$
2
4
8
16
32
64
128
256
512
Frequency
$\tau_{0A} + \tau_{1A}$

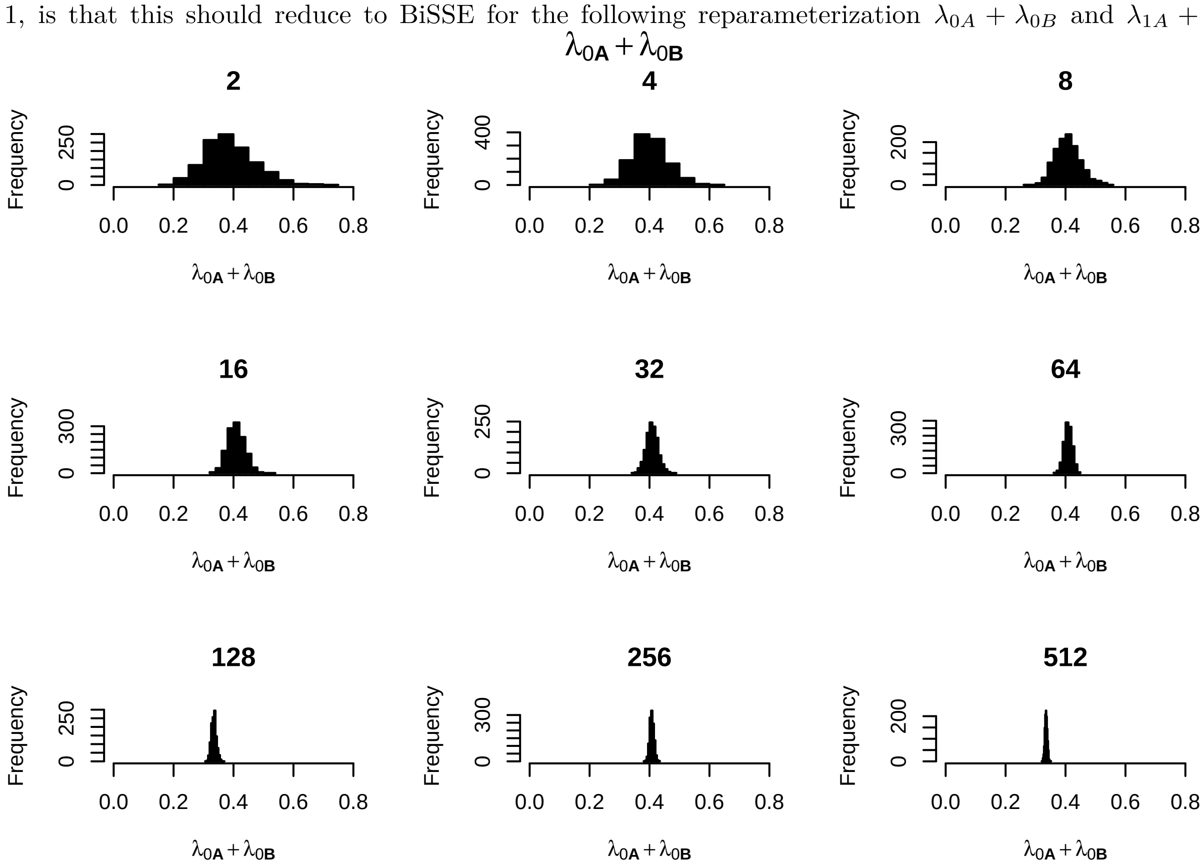


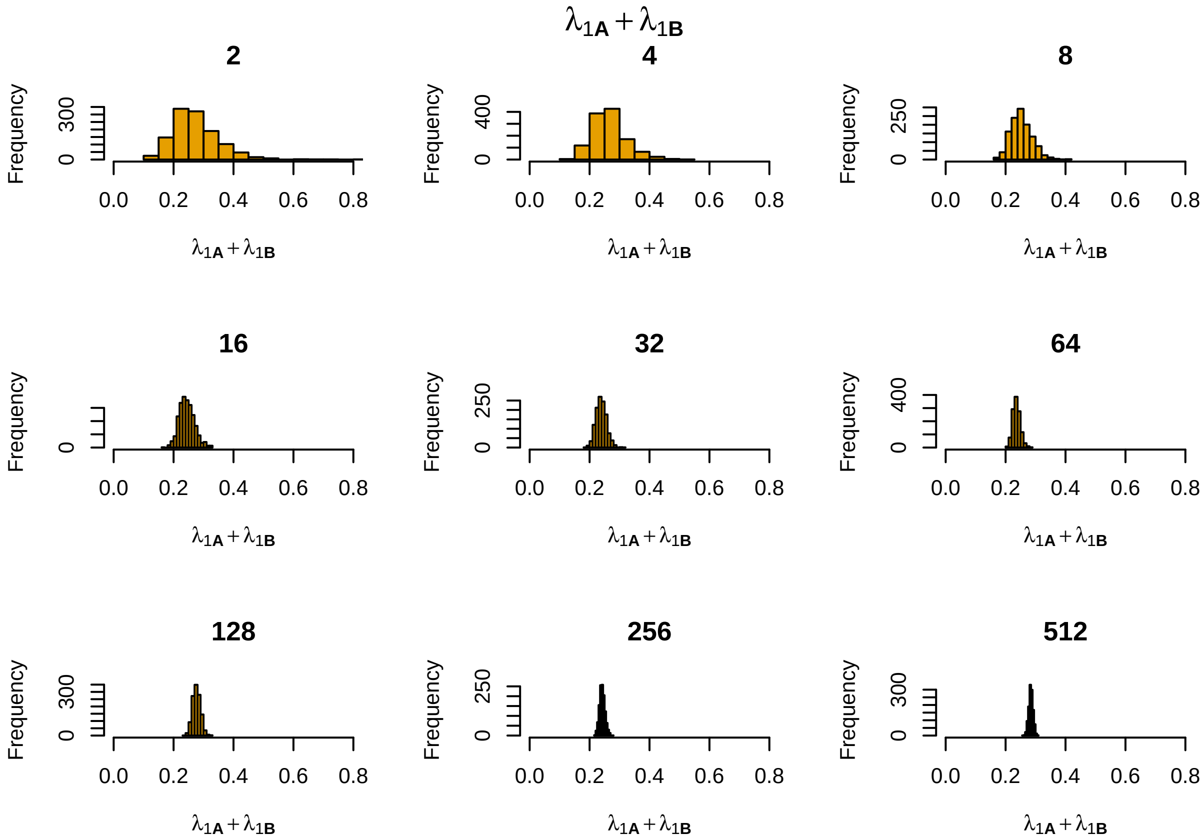
$\tau_{0B} + \tau_{1B}$
2
4
8
16
32
64
128
256
512
Frequency
$\tau_{0B} + \tau_{1B}$

B) Speciation rates

1. Checks for addition $\lambda_{0A} + \lambda_{0B}$ AND $\lambda_{1A} + \lambda_{1B}$

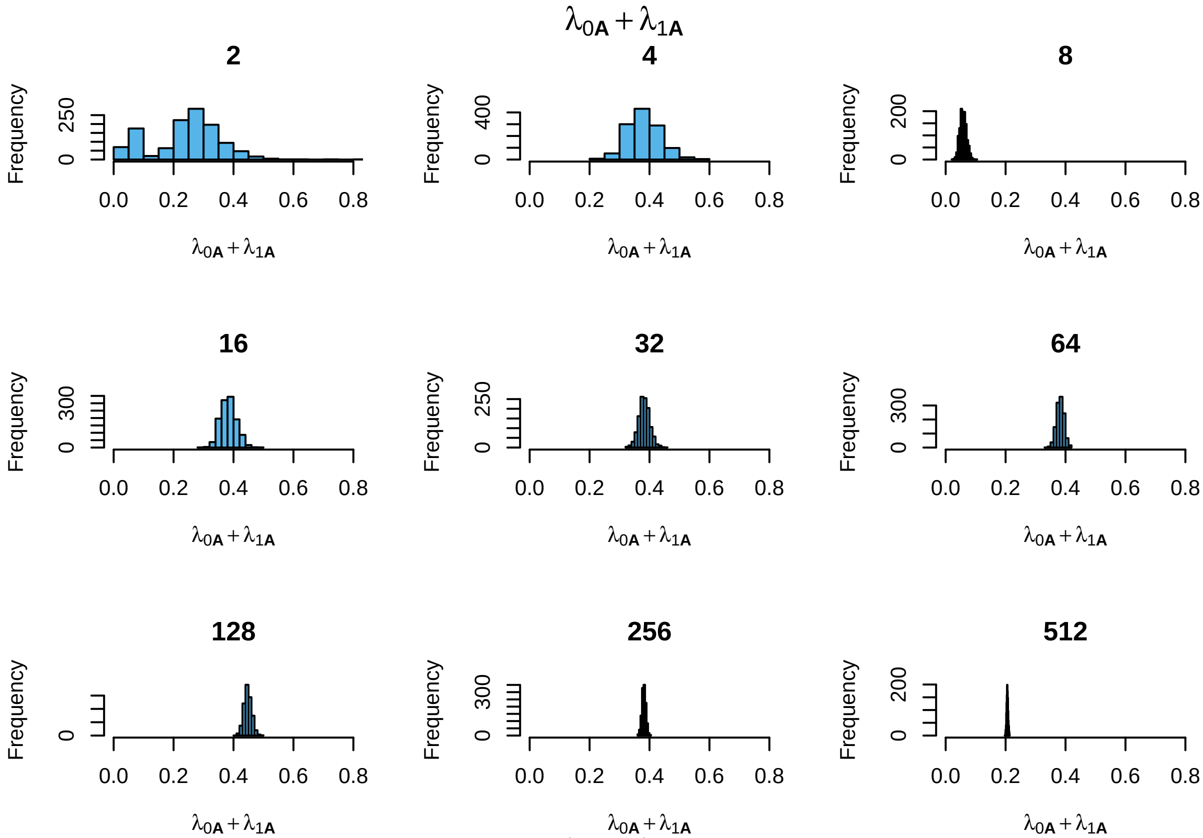
My reason behind adding speciation rates for state 0A and 0B into state 0 and state 1A and 1B to state 1, is that this should reduce to BiSSE for the following reparameterization $\lambda_{0A} + \lambda_{0B}$ and $\lambda_{1A} + \lambda_{1B}$.

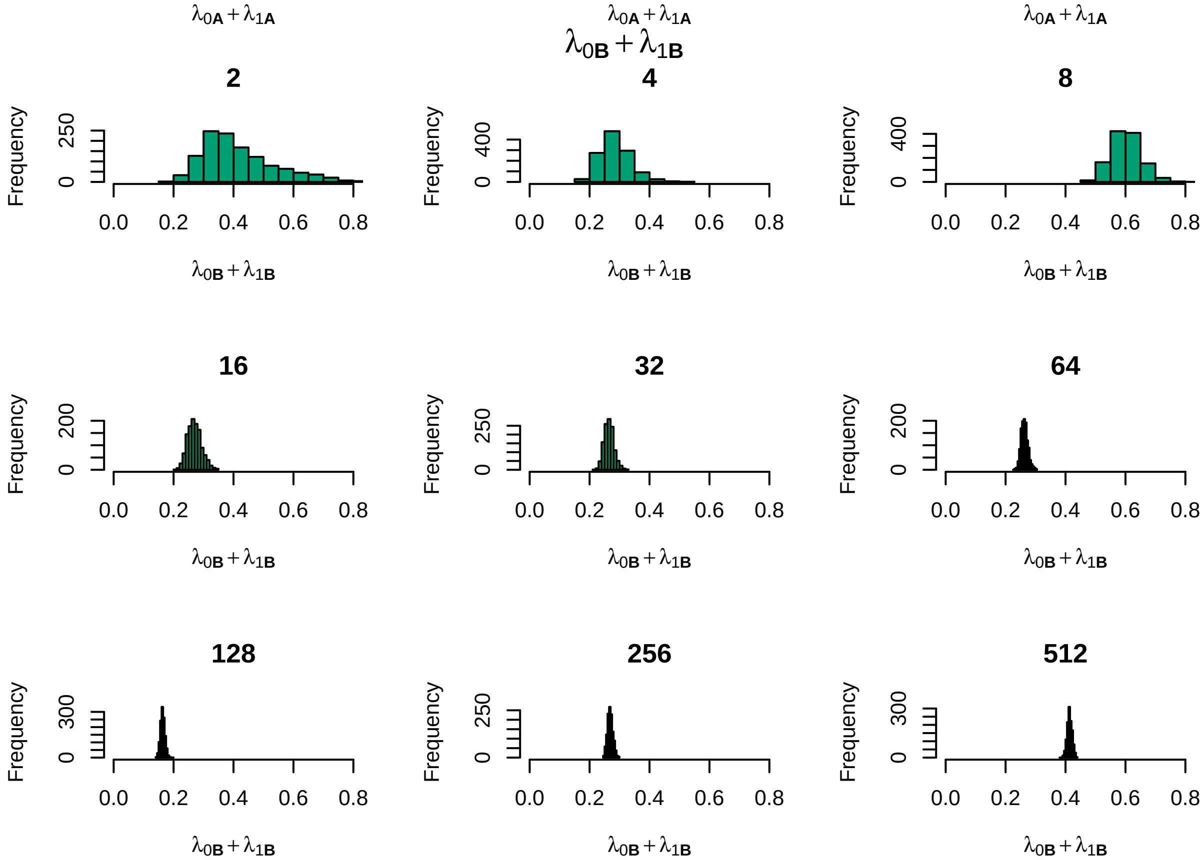




2. Checks for addition $\lambda_{0A} + \lambda_{1A}$ AND $\lambda_{0B} + \lambda_{1B}$

Here I am checking if hidden states have a signal in speciation rates i.e. if the two rate classes A and B can also be combined. Here state A is represented by the sum $\lambda_{0A} + \lambda_{1A}$ and state B is represented by the sum $\lambda_{0B} + \lambda_{1B}$.

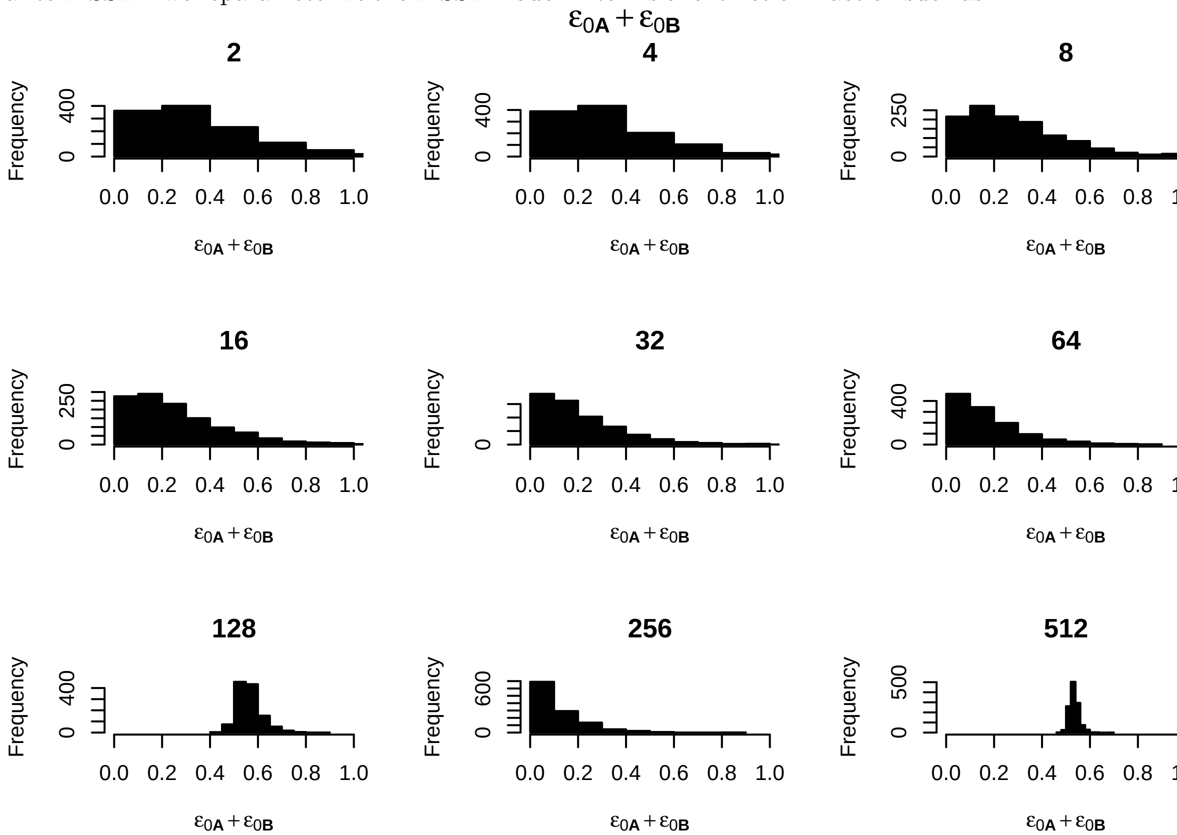

$\lambda_{0A} + \lambda_{1A}$
2
4
8
16
32
64
128
256
512
Frequency
$\lambda_{0A} + \lambda_{1A}$


$\lambda_{0B} + \lambda_{1B}$
2
4
8
16
32
64
128
256
512
Frequency
$\lambda_{0B} + \lambda_{1B}$

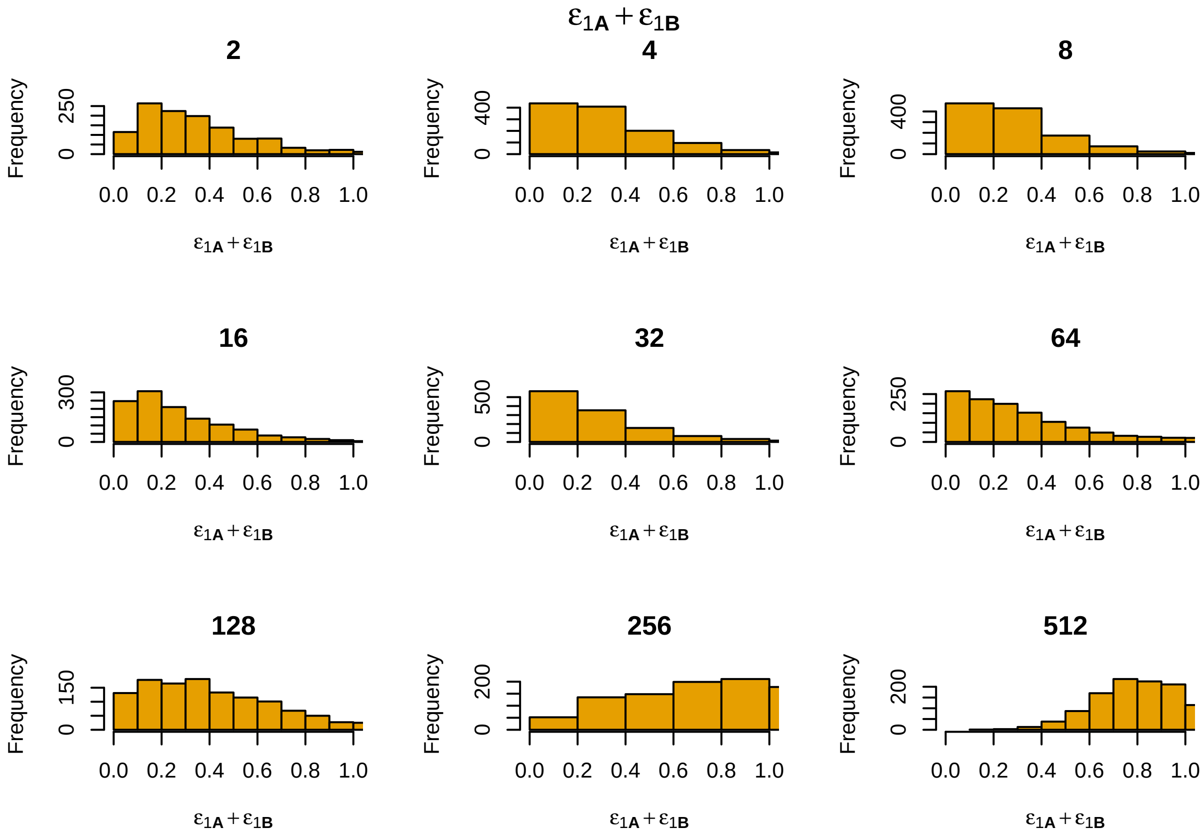
C) Extinction fractions

1. Checks for addition $\epsilon_{0A} + \epsilon_{0B}$ AND $\epsilon_{1A} + \epsilon_{1B}$

Here we are adding extinction fractions rates for state 0A and 0B into state 0 and state 1A and 1B to state 1, is that this should be similar to BiSSE if we reparameterize the BiSSE model in terms of extinction fraction such as

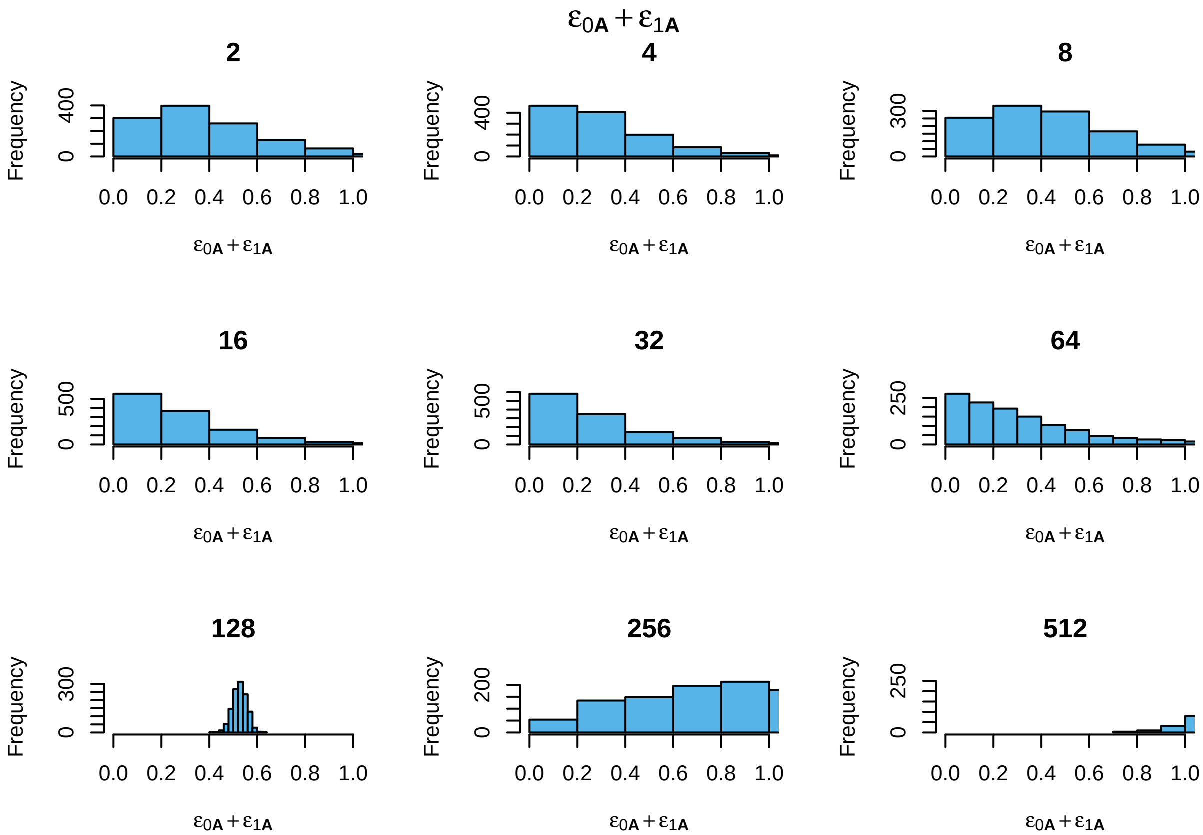


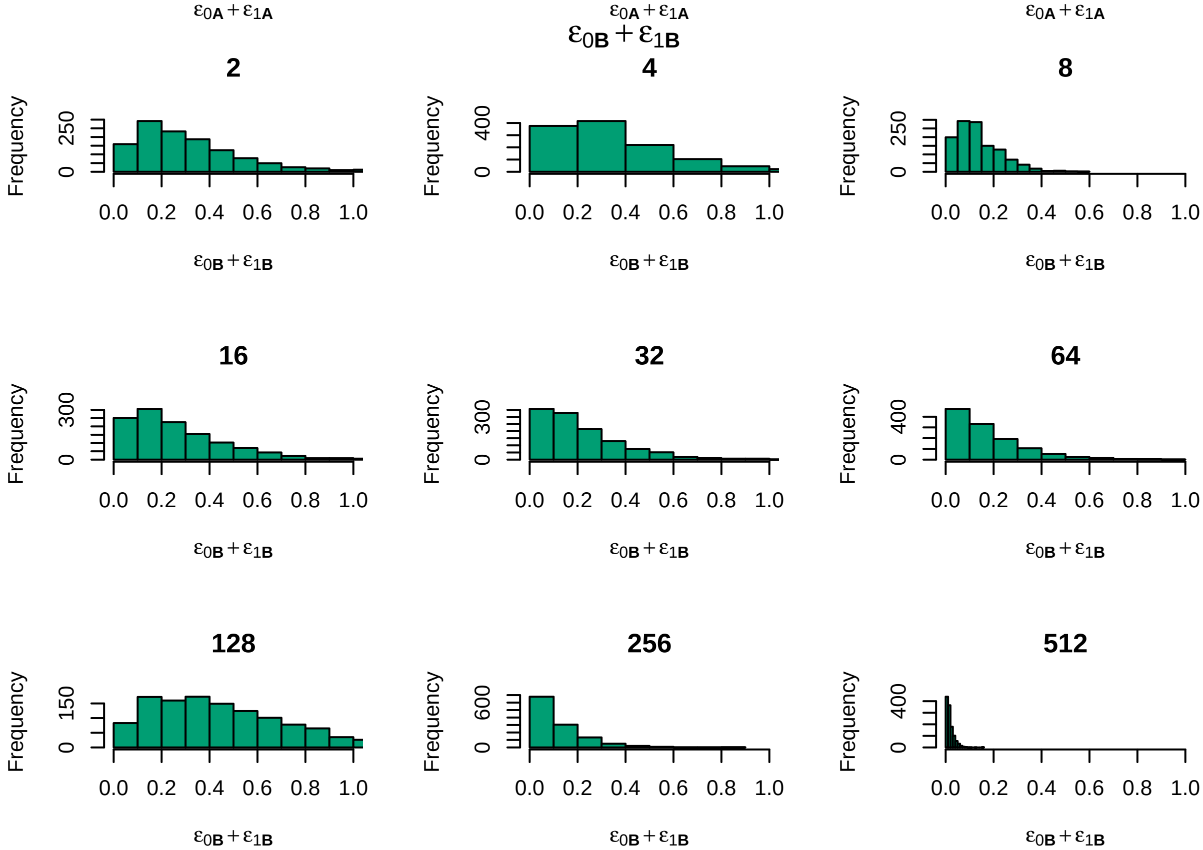
$\epsilon_{0A}+\epsilon_{0B}$ and $\epsilon_{1A}+\epsilon_{1B}$.



2. Checks for addition $\epsilon_{0A} + \epsilon_{1A}$ AND $\epsilon_{0B} + \epsilon_{1B}$

Checking if the hidden states have a signal when combining extinction fractions i.e. if the two rate classes A and B can also be combined. Here state A is represented by the sum $\epsilon_{0A} + \epsilon_{1A}$ and state B is represented by the sum $\epsilon_{0B} + \epsilon_{1B}$.

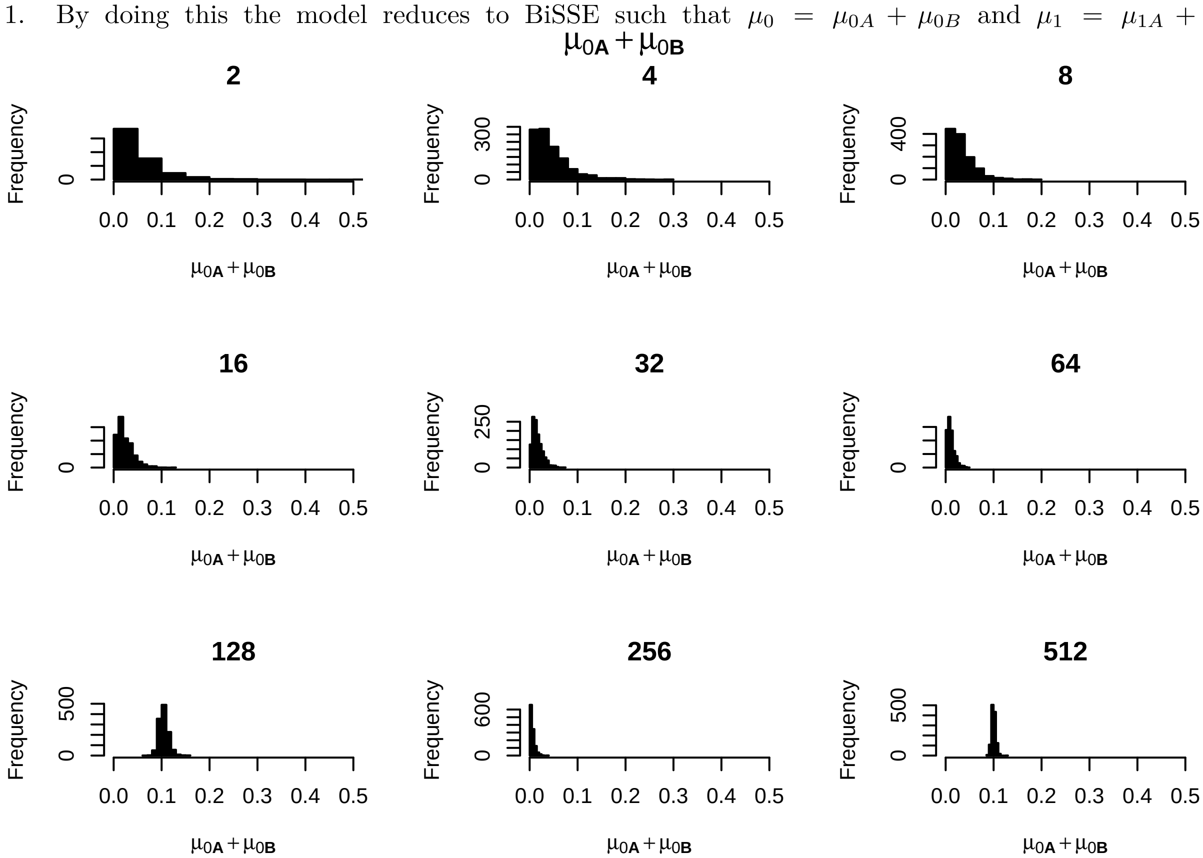

$\varepsilon_{0A} + \varepsilon_{1A}$
2
4
8
16
32
64
128
256
512
Frequency
$\varepsilon_{0A} + \varepsilon_{1A}$

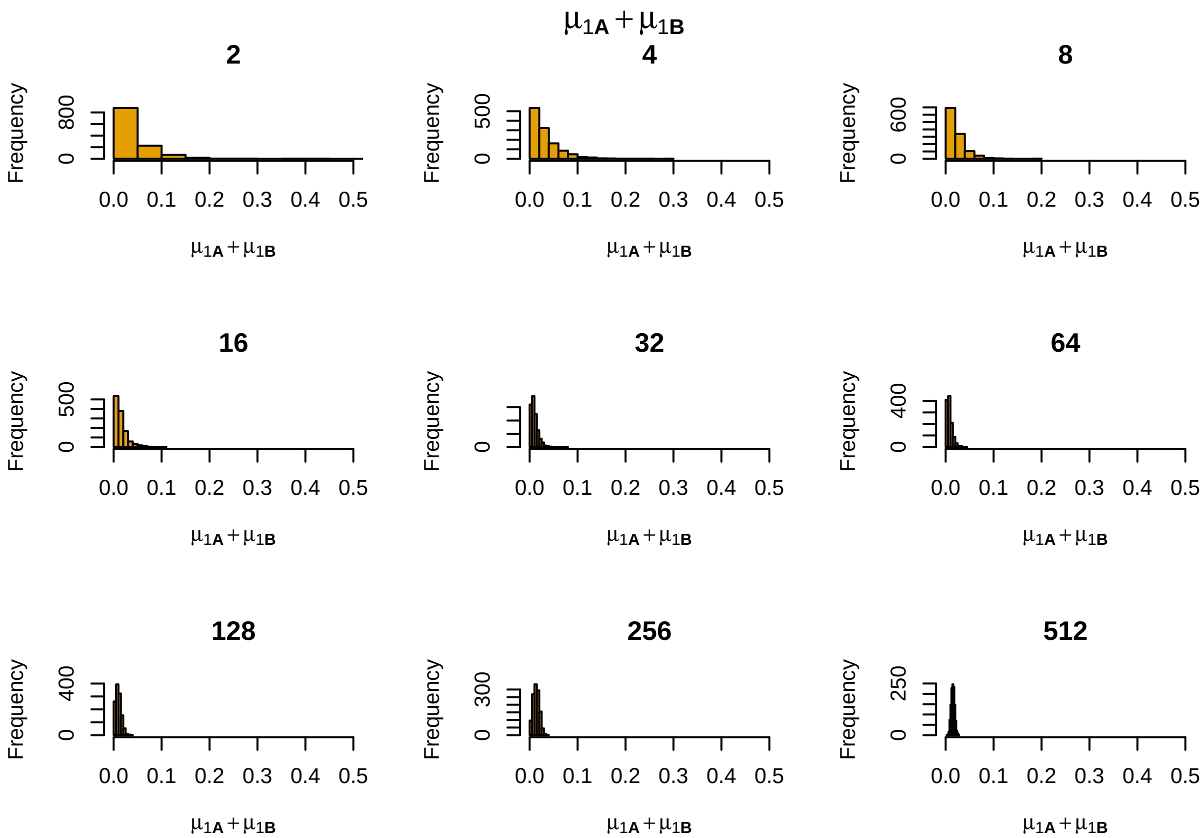

$\varepsilon_{0B} + \varepsilon_{1B}$
2
4
8
16
32
64
128
256
512
Frequency
$\varepsilon_{0B} + \varepsilon_{1B}$

D) Extinction rates

1. Checks for addition $\mu_{0A} + \mu_{0B}$ AND $\mu_{1A} + \mu_{1B}$

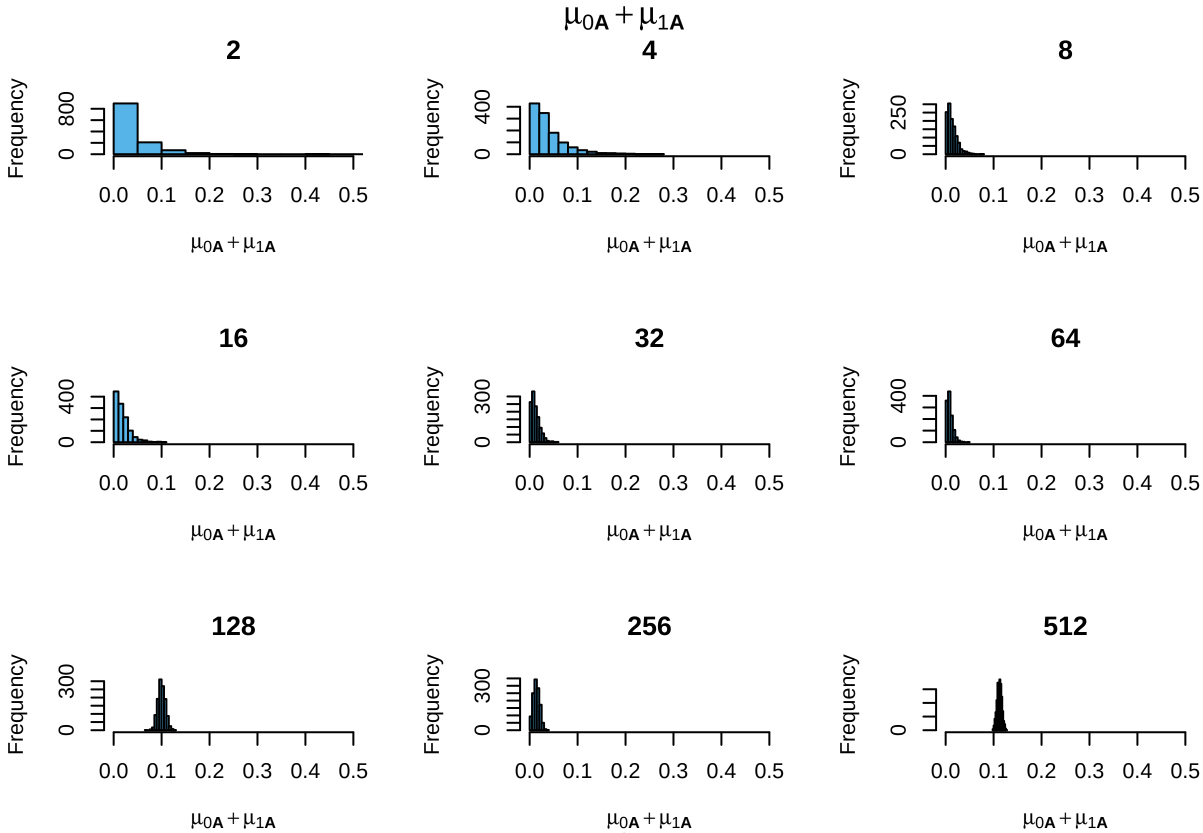
I am adding the extinction rates for state 0A and 0B into state 0 and state 1A and 1B to state 1. By doing this the model reduces to BiSSE such that $\mu_0 = \mu_{0A} + \mu_{0B}$ and $\mu_1 = \mu_{1A} + \mu_{1B}$.

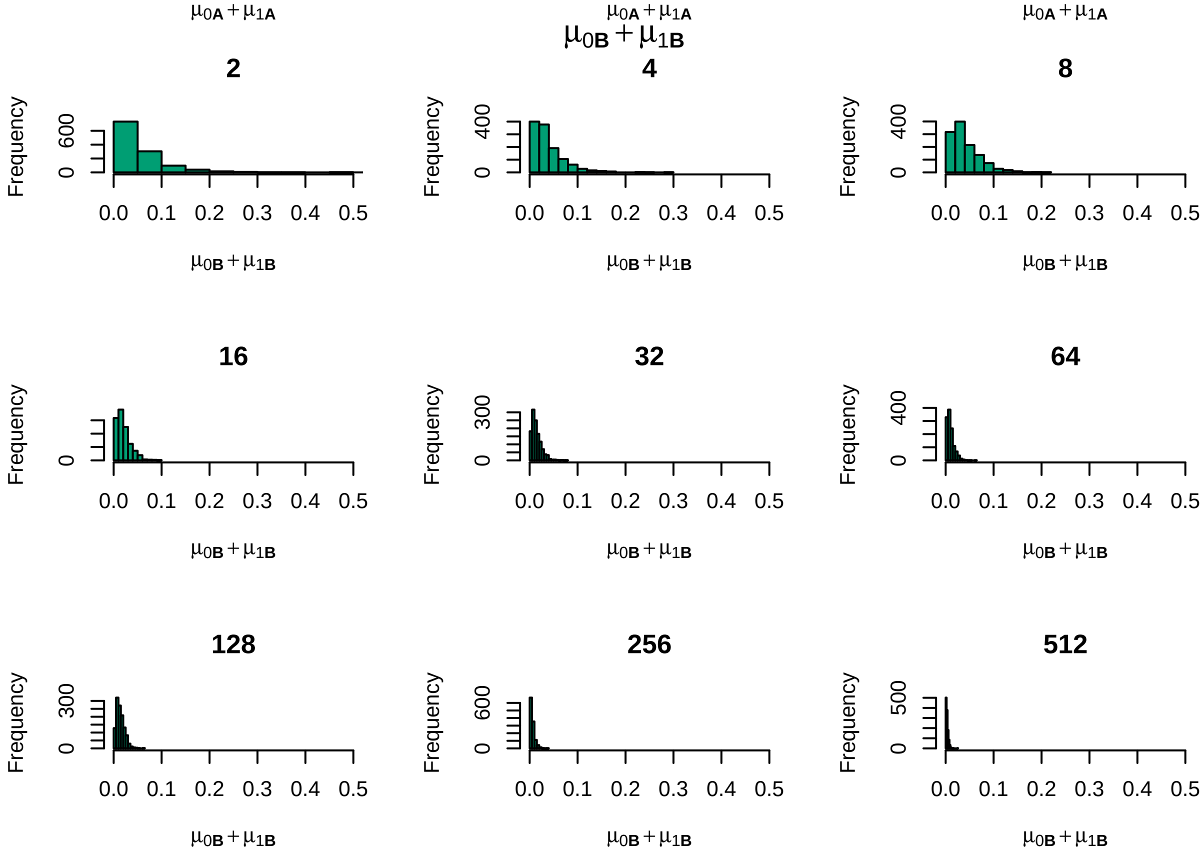




2. Checks for addition $\mu_{0A} + \mu_{1A}$ AND $\mu_{0B} + \mu_{1B}$

Checking if hidden states have a signal when combining extinction rates i.e. if the two rate classes A and B can also be combined. Here state A is represented by the sum $\mu_{0A} + \mu_{1A}$ and state B is represented by the sum $\mu_{0B} + \mu_{1B}$.


μ0A + μ1A
2
4
8
16
32
64
128
256
512
Frequency
μ0A + μ1A
0.0 0.1 0.2 0.3 0.4 0.5

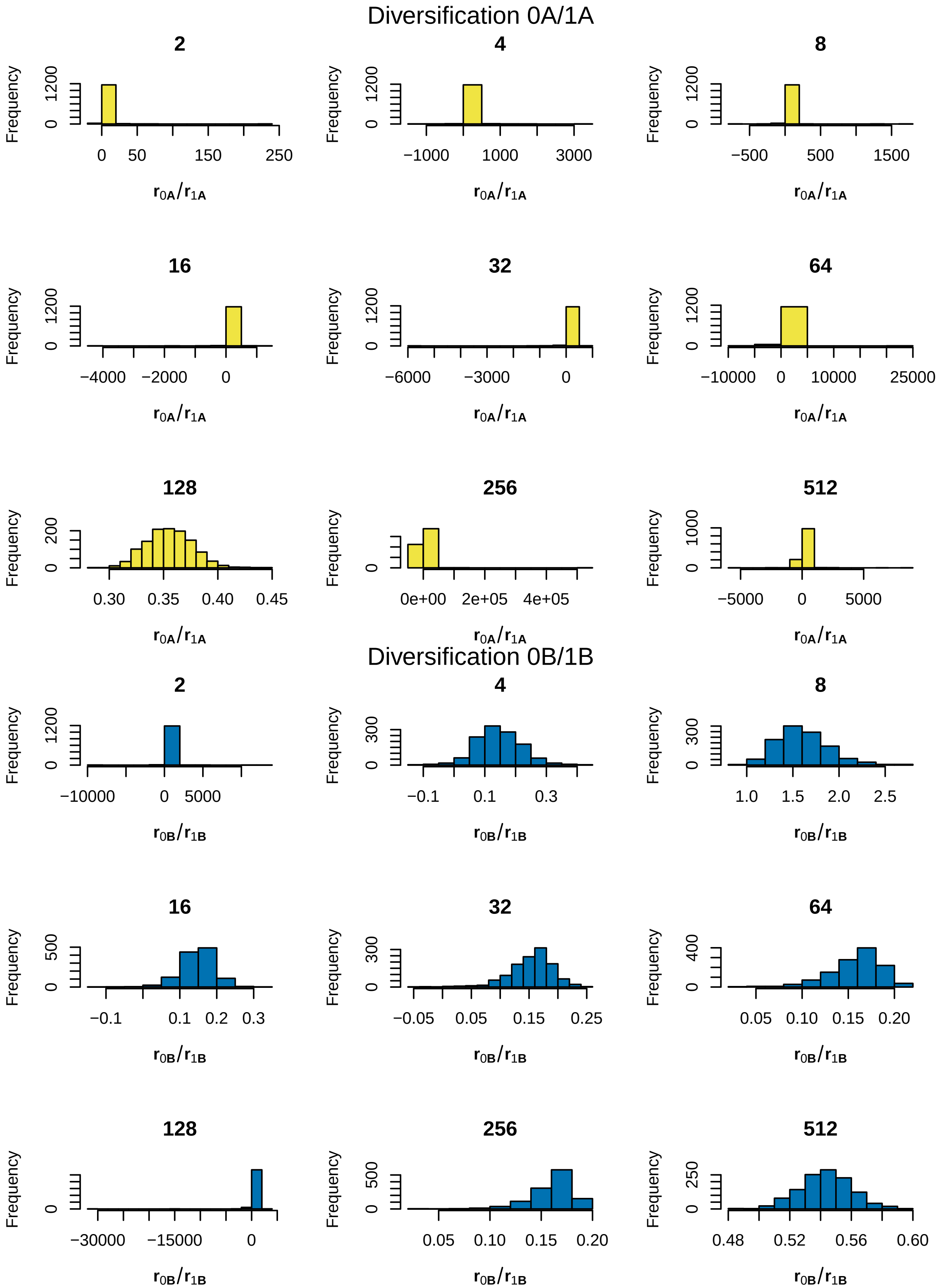

μ0B + μ1B
2
4
8
16
32
64
128
256
512
Frequency
μ0B + μ1B
0.0 0.1 0.2 0.3 0.4 0.5

(II) Diversification rates check “r”:

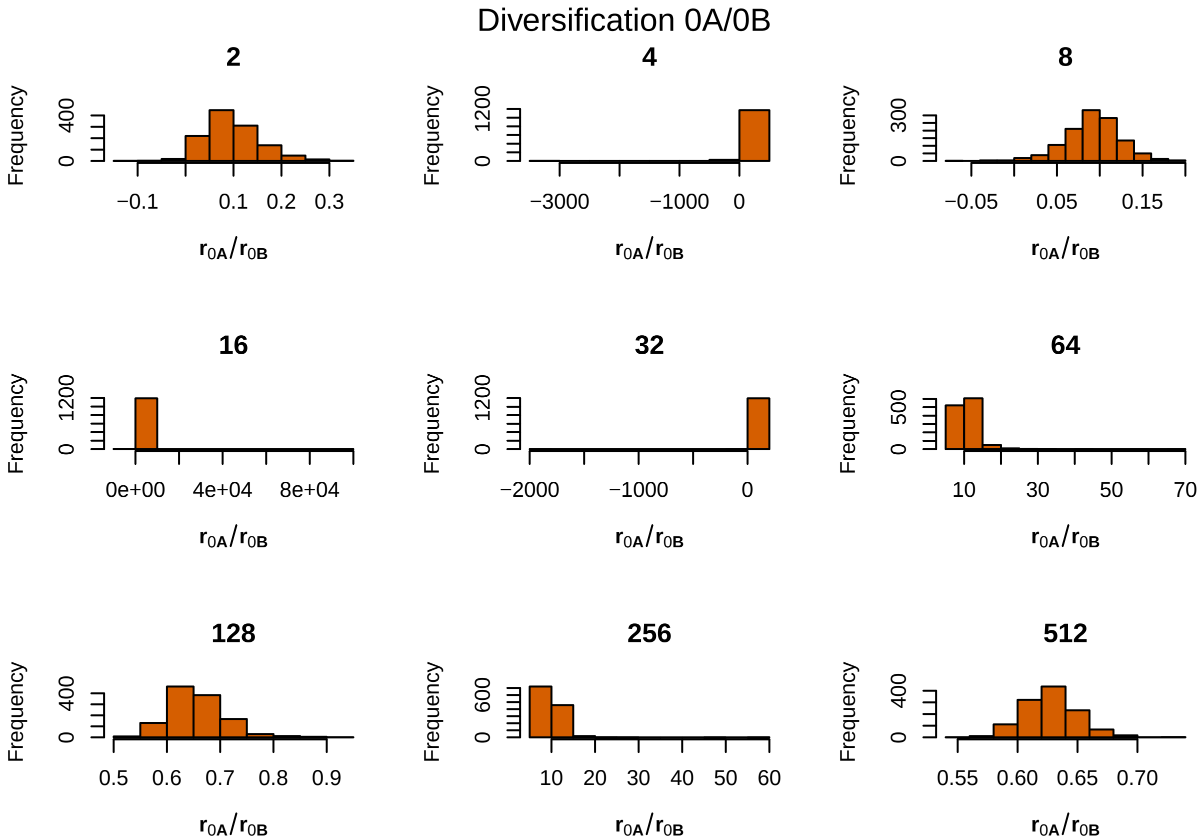
A) Checking if r_{0A}/r_{1A} and r_{0B}/r_{1B} are convergent. i.e. diversification rate differences per state, which checks whether state 0 has a different diversification rate than state 1

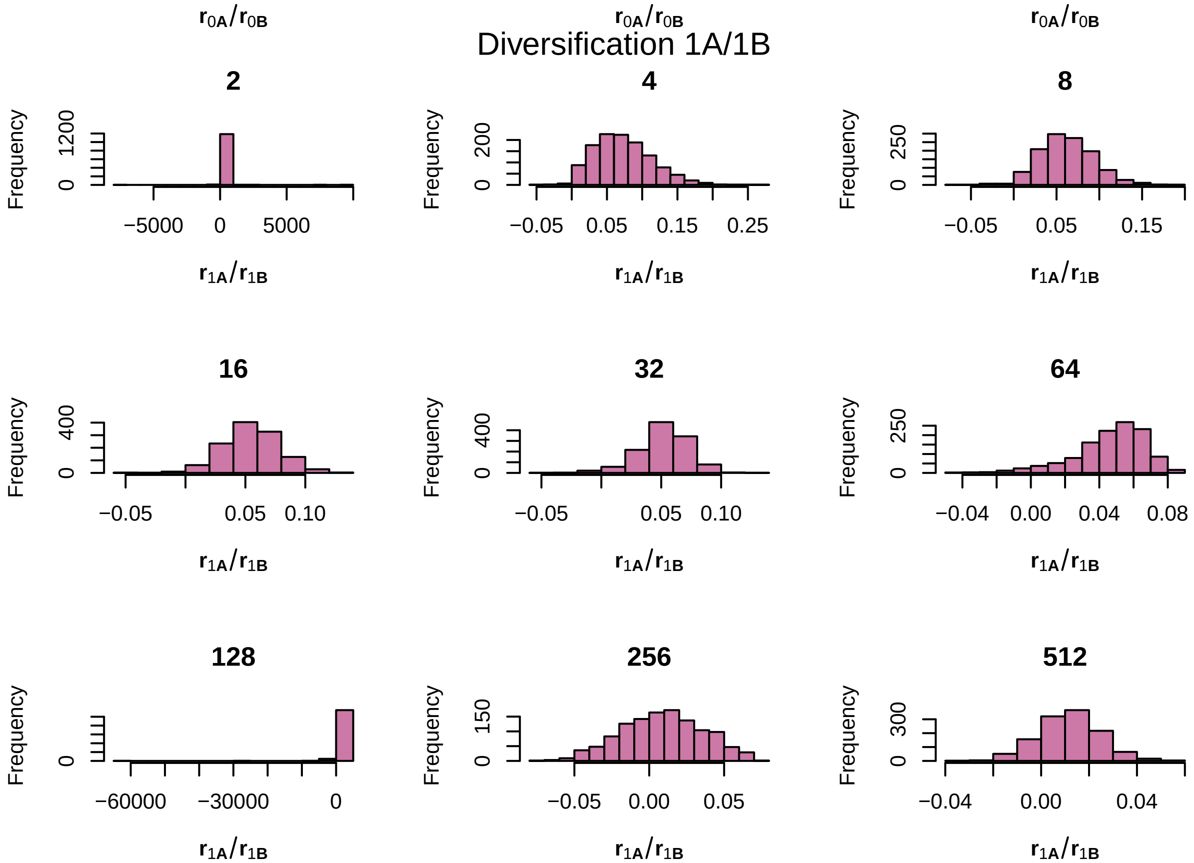
B) Checking r_{0A}/r_{0B} and r_{1A}/r_{1B}. i.e. diversification rate differences per hidden state i.e if hidden state for state 0 is different than what is observed (separating the main effect vs. the noise)

A) r_{0A}/r_{1A} and r_0B/r_1B. - Checking convergence



B) r_{0A}/r_{0B} annd r_{1A}/r_{1B} - Checking Noise





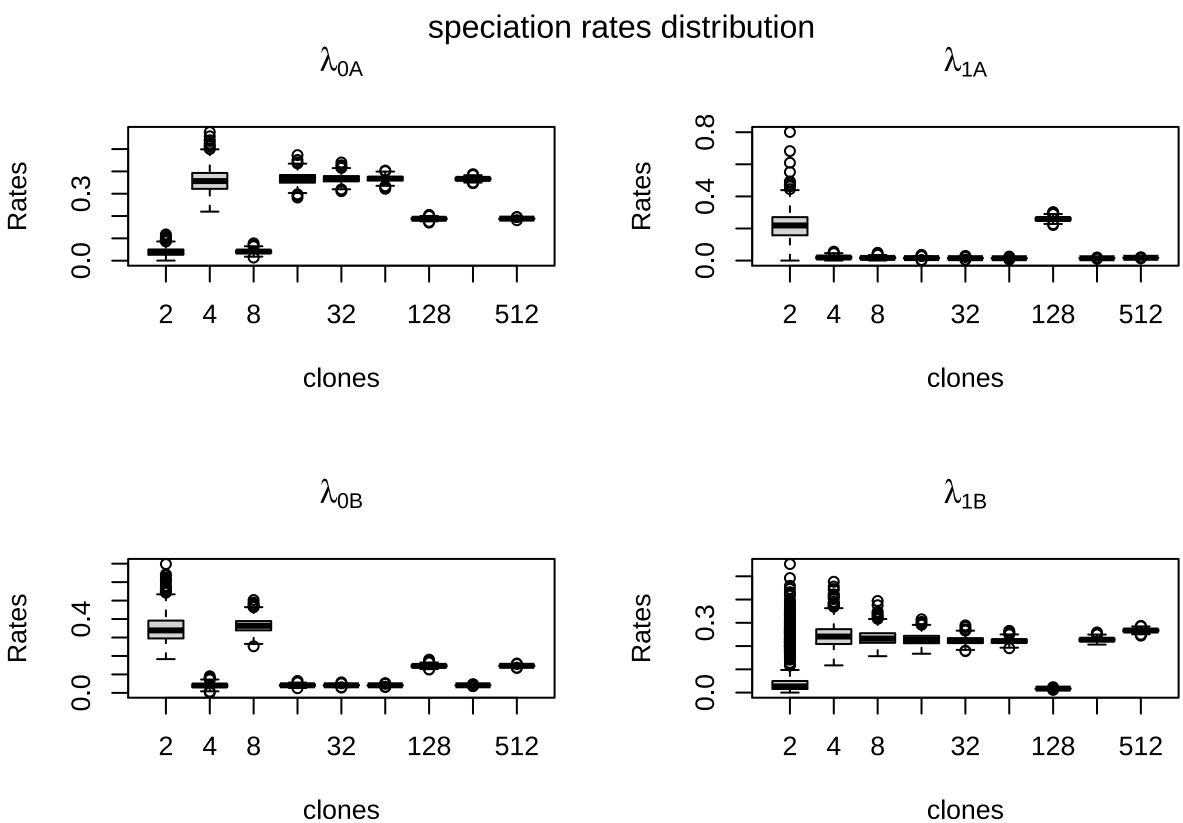
#

Why we might be seeing the above results ## 1. Distribution of lambda and mu and diversification rates for each clone These boxplots show the distribution of speciation rates $\lambda_{0A}, \lambda_{1A}, \lambda_{0B}, \lambda_{1B}$ and extinction rates $\mu_{0A}, \mu_{1A}, \mu_{0B}, \mu_{1B}$ calculated from HiSSE's turnover rates and extinction fractions.

Please note that for some clones the extinction rate is high leading to negative diversification rates. I added a line y=0 in diversification rates distribution plot to demonstrate that point.

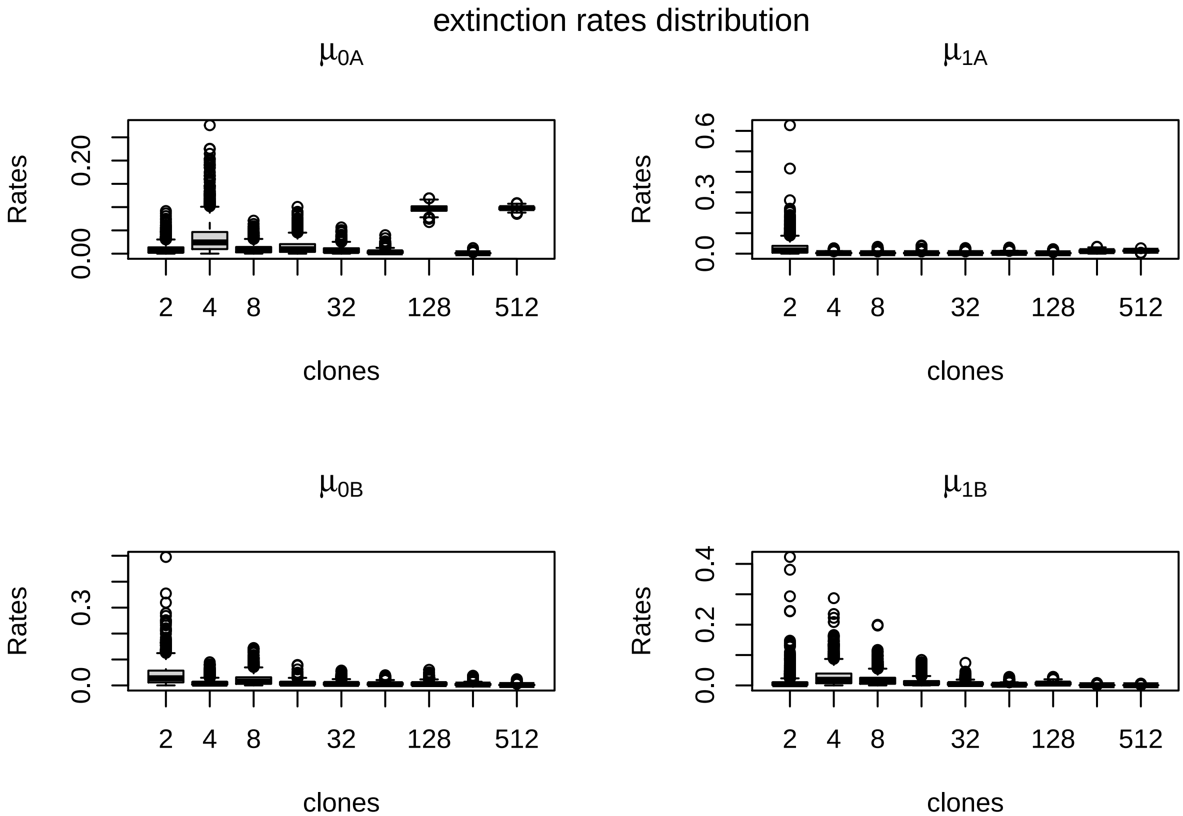
```
#Format  1=0A, 2=1A, 3=0B, 4=1B.

# speciation rates distribution
#png("speciationRateDistribution.png")
par(mfrow=c(2,2))
boxplot(lambda1.his.clone, main=expression(lambda[0][A]),ylab="Rates",xlab="clones")
boxplot(lambda2.his.clone, main=expression(lambda[1][A]),ylab="Rates",xlab="clones")
boxplot(lambda3.his.clone, main=expression(lambda[0][B]),ylab="Rates",xlab="clones")
boxplot(lambda4.his.clone, main=expression(lambda[1][B]),ylab="Rates",xlab="clones")
mtext("speciation rates distribution", side =3, line = -1.5, outer = TRUE)
```



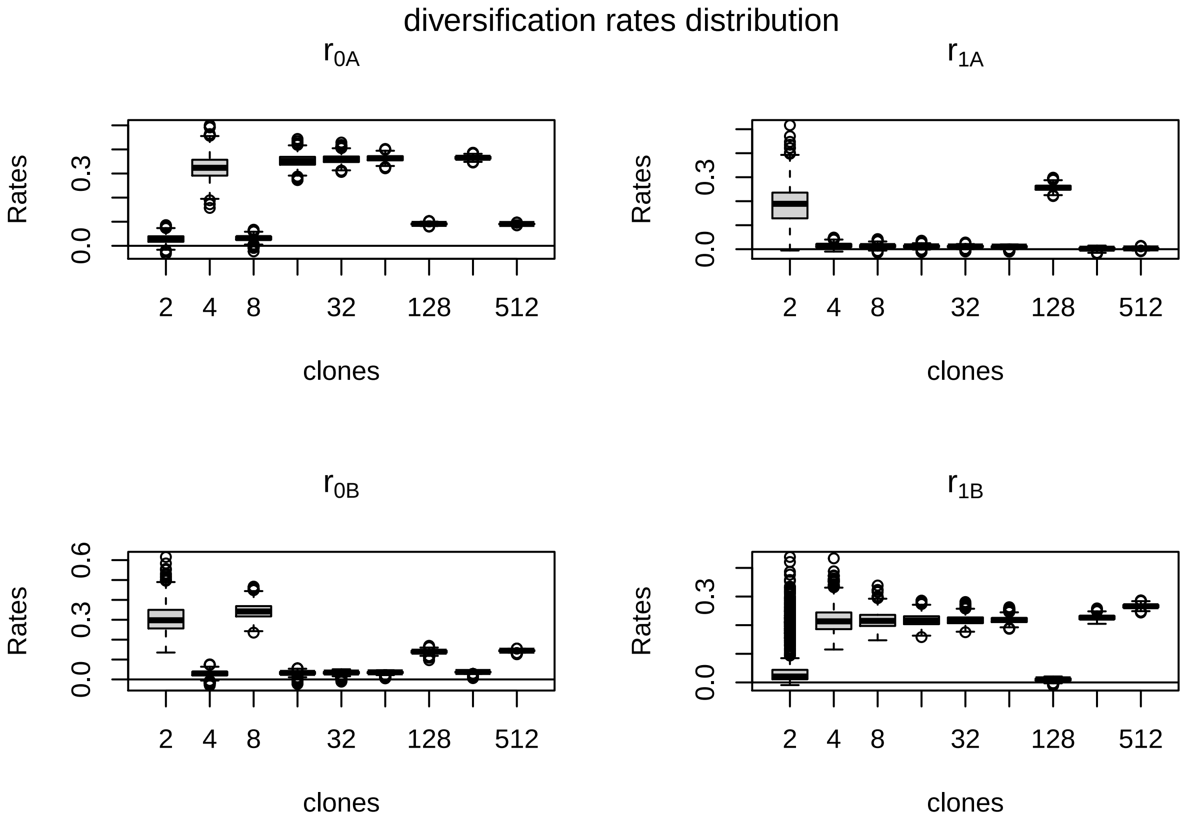

```
#dev.off()

# extinction rates distribution
#png("extinctionRateDistribution.png")
par(mfrow=c(2,2))
boxplot(mu1.his.clone, main=expression(mu[0][A]),xlab="clones",ylab="Rates")
boxplot(mu2.his.clone, main=expression(mu[1][A]),xlab="clones",ylab="Rates")
boxplot(mu3.his.clone, main=expression(mu[0][B]),xlab="clones",ylab="Rates")
boxplot(mu4.his.clone, main=expression(mu[1][B]),xlab="clones",ylab="Rates")
mtext("extinction rates distribution", side =3, line = -1.5, outer = TRUE)
```




```
#dev.off()

# diversification rates distribution
#png("diversificationRateDistribution.png")
par(mfrow=c(2,2))
boxplot(div.rate1, main=expression(r[0][A]),xlab="clones",ylab="Rates")
abline(h=0)
boxplot(div.rate2, main=expression(r[1][A]),xlab="clones",ylab="Rates")
abline(h=0)
boxplot(div.rate3, main=expression(r[0][B]),xlab="clones",ylab="Rates")
abline(h=0)
boxplot(div.rate4, main=expression(r[1][B]),xlab="clones",ylab="Rates")
abline(h=0)
mtext("diversification rates distribution", side =3, line = -1.5, outer = TRUE)
```

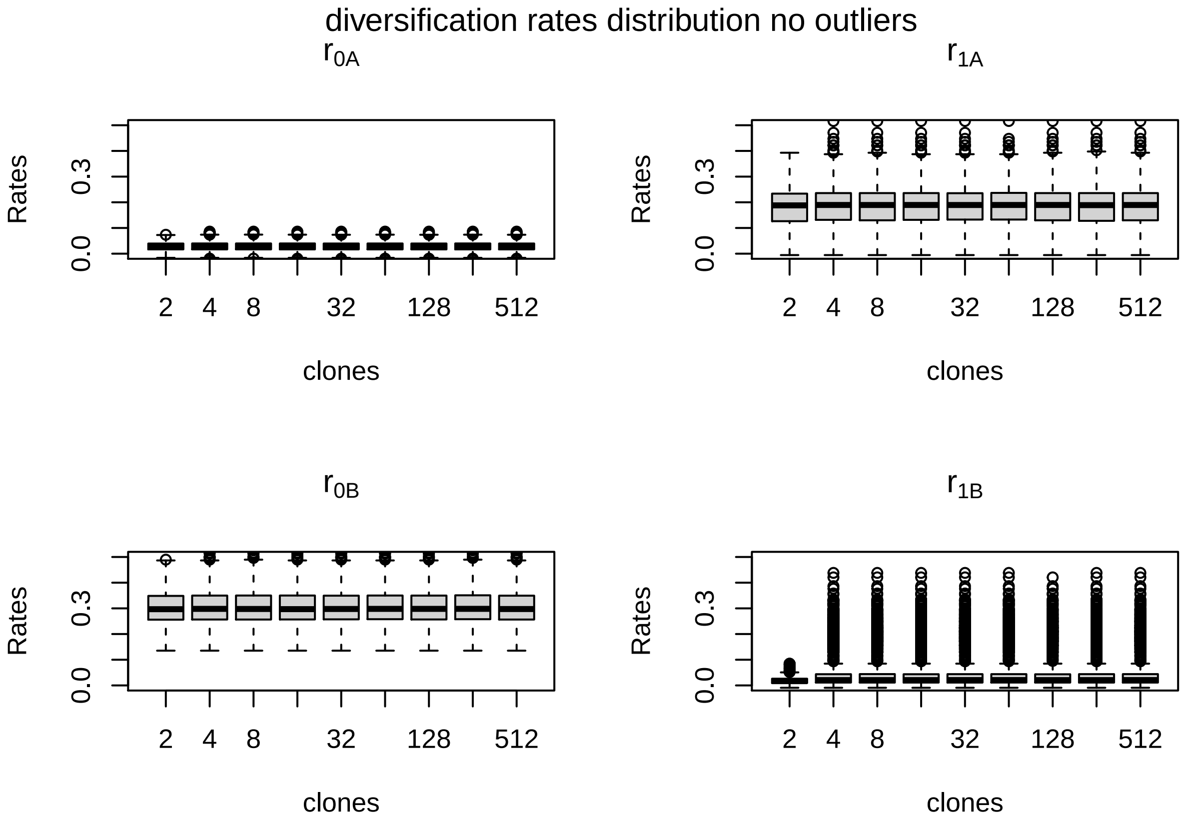



```
#dev.off()
```

2.Removing the outliers

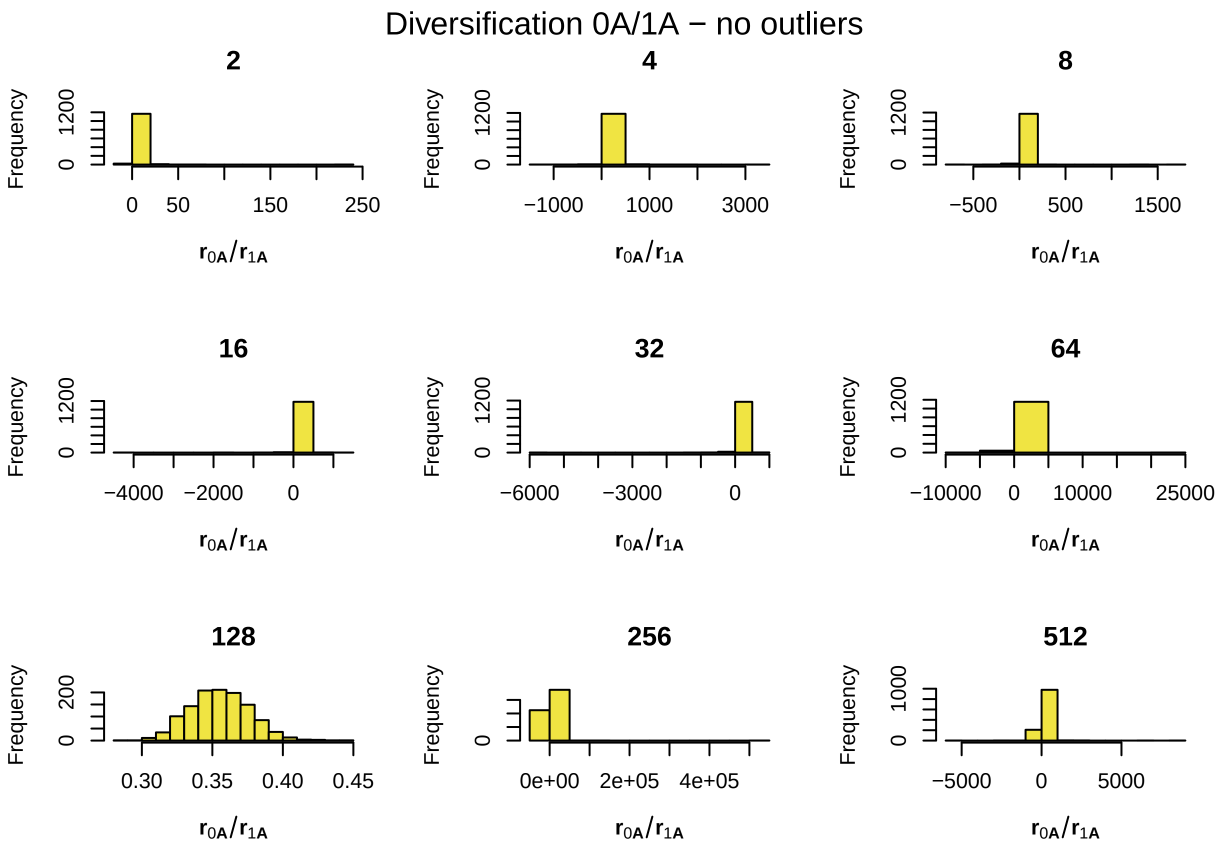
3. Distribution of diversification rates after removing outliers

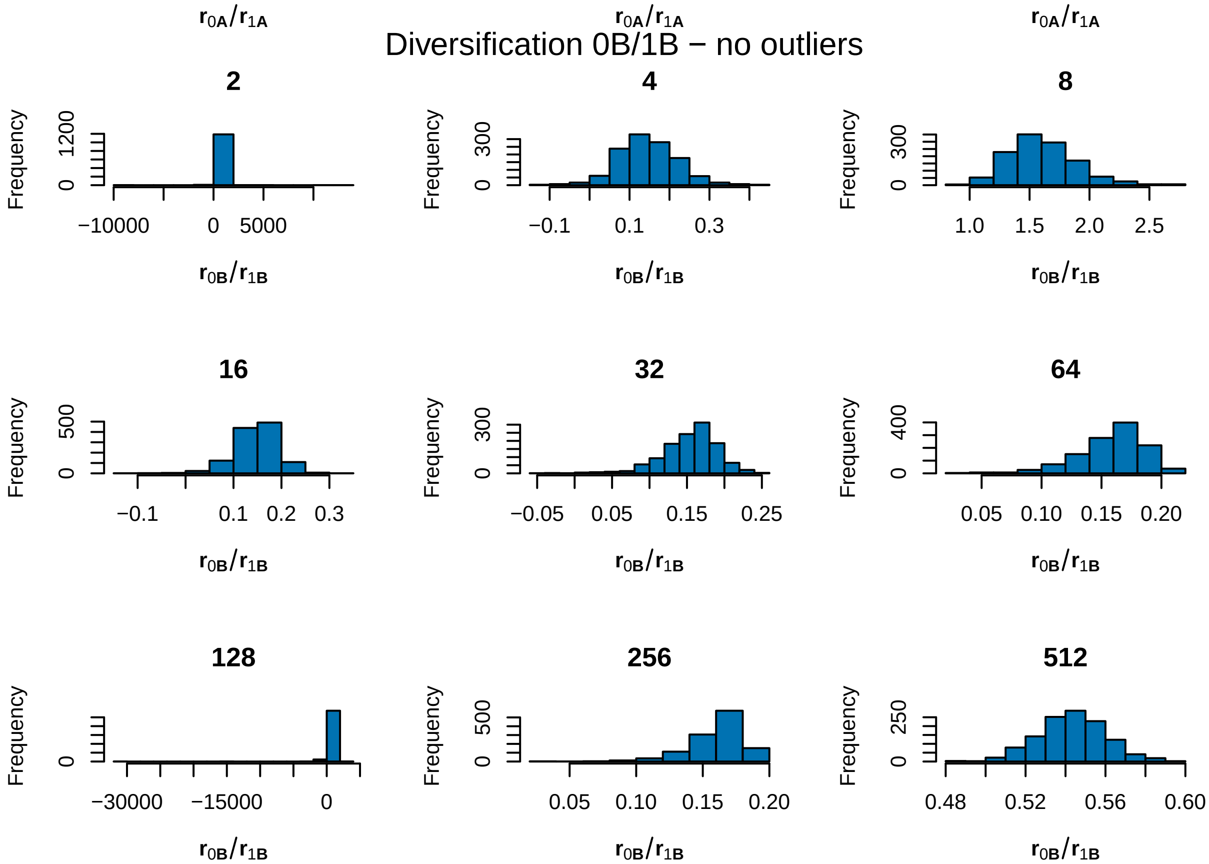
```
# Combine the above individual rates
#png("diversificationRateDistribution_outliersRemoved.png")
par(mfrow=c(2,2))
boxplot(x1,main=expression(r[0][A]),ylab="Rates",xlab="clones",ylim=c(0,0.5))
boxplot(x2,main=expression(r[1][A]),ylab="Rates",xlab="clones",ylim=c(0,0.5))
boxplot(x3,main=expression(r[0][B]),ylab="Rates",xlab="clones",ylim=c(0,0.5))
boxplot(x4,main=expression(r[1][B]),ylab="Rates",xlab="clones",ylim=c(0,0.5))
mtext("diversification rates distribution no outliers", side =3, line = -1.5, outer = TRUE)
```


diversification rates distribution no outliers
r_{0A}
r_{1A}
r_{0B}
r_{1B}
Rates
0.0
0.3
2
4
8
32
128
512
clones

```r
#dev.off()
```

A) r_{0A}/r_{1A} and r_0B/r_1B. - Checking convergence -Outliers removed





B) r_{0A}/r_{0B} annd r_{1A}/r_{1B} - Checking Noise - Outliers Removed