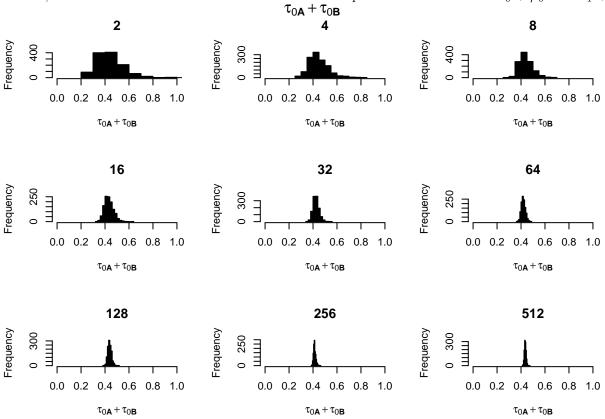
HiSSEChecks

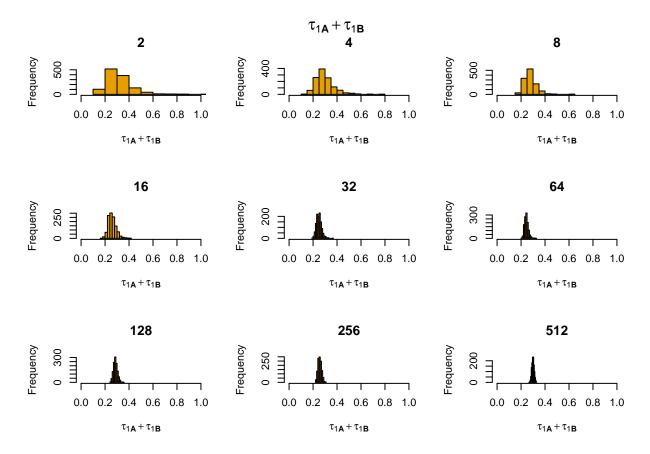
(I) Parameter combinations -

A) Turnover rates

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

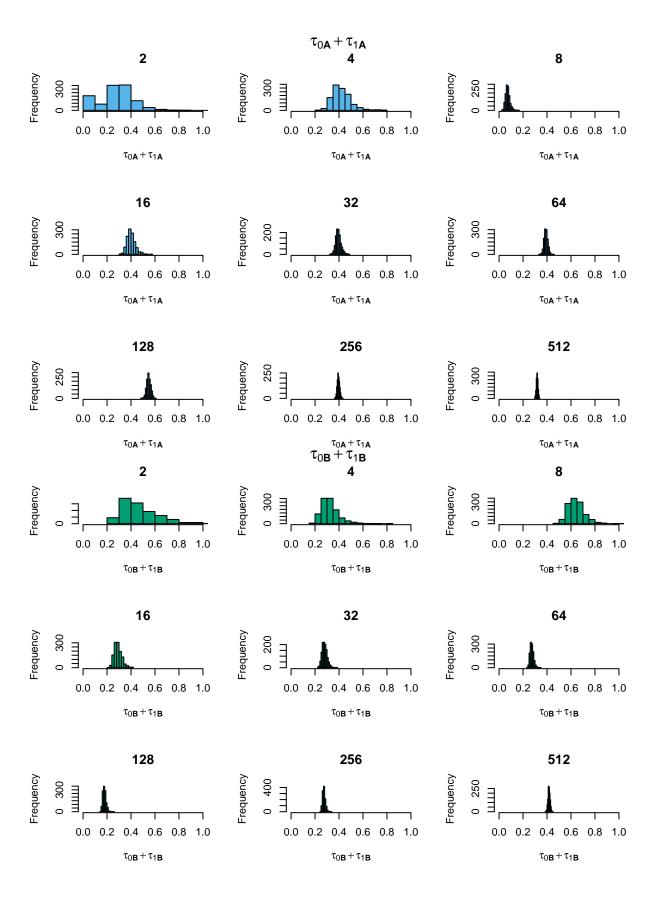
My reason behind adding turnover rates for state 0A and 0B into state 0 and state 1A and 1B to state 1, is that this should be similar to BiSSE if we reparameterize BiSSE as $\lambda_0 + \mu_0$ and $\lambda_1 + \mu_1$.





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

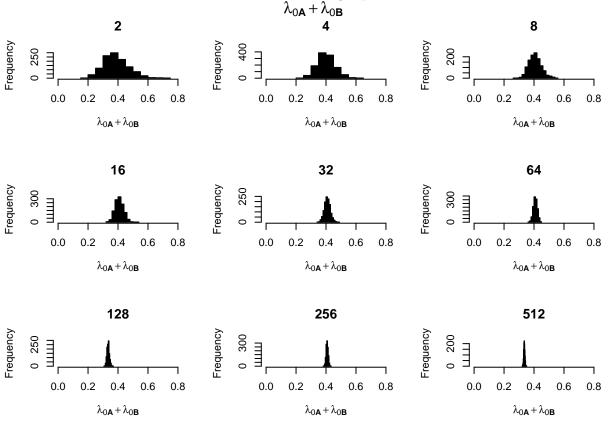
Here I am checking if hidden states have a signal in turnover rates i.e. if the two rate classes A and B can also be combined. Here state A is represented by the sum $\tau_{0A} + \tau_{1A}$ and state B is represented by the sum $\tau_{0B} + \tau_{1B}$.

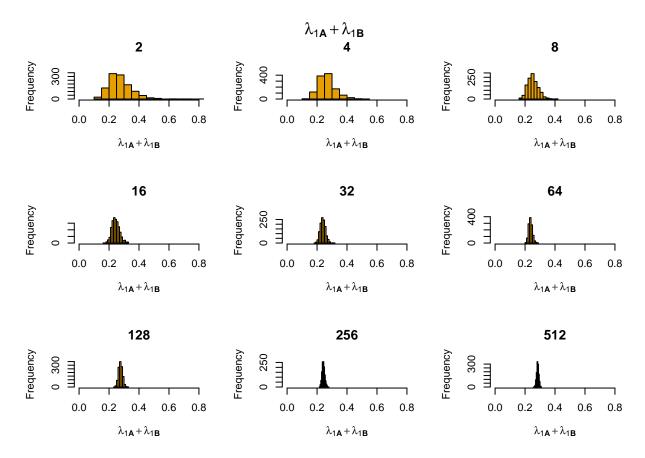


B) Speciation rates

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

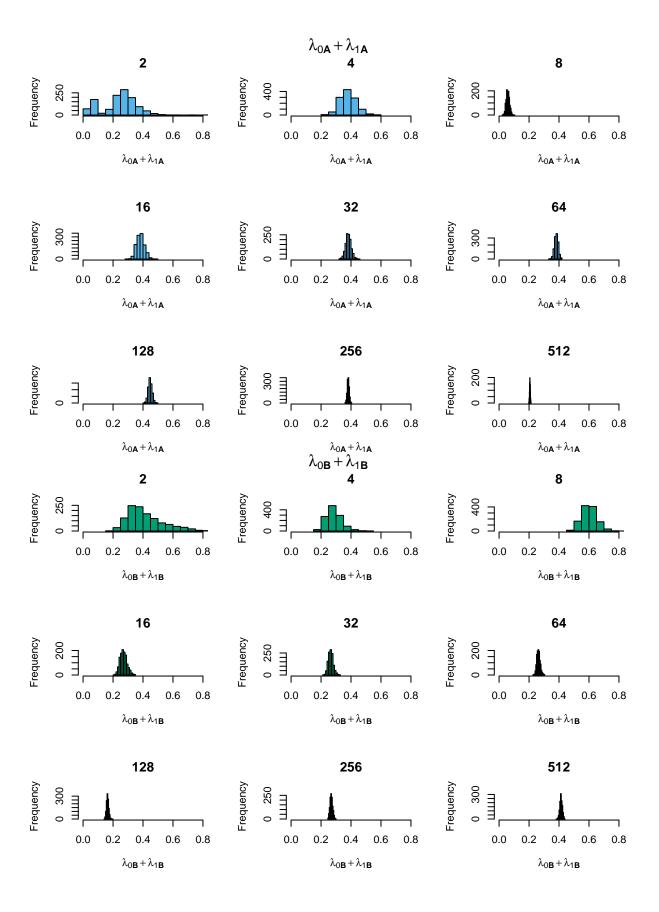
My reason behind adding speciation rates for state 0A and 0B into state 0 and state 1A and 1B to state 1, is that this should reduce to BiSSE for the following reparameterization $\lambda_{0A} + \lambda_{0B}$ and $\lambda_{1A} + \lambda_{1B}$.





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

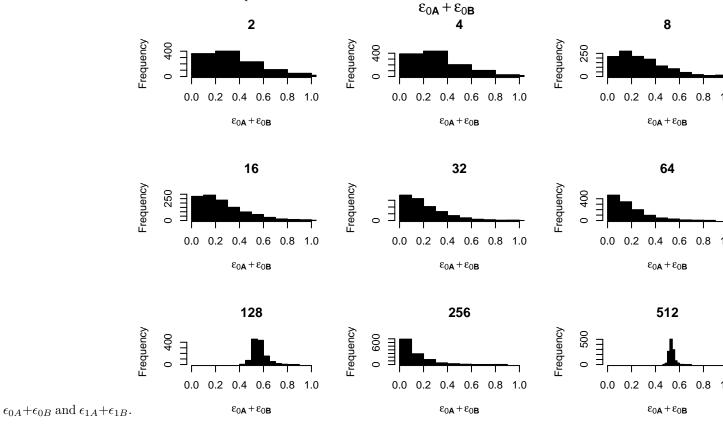
Here I am checking if hidden states have a signal in speciation rates i.e. if the two rate classes A and B can also be combined. Here state A is represented by the sum $\lambda_{0A} + \lambda_{1A}$ and state B is represented by the sum $\lambda_{0B} + \lambda_{1B}$.

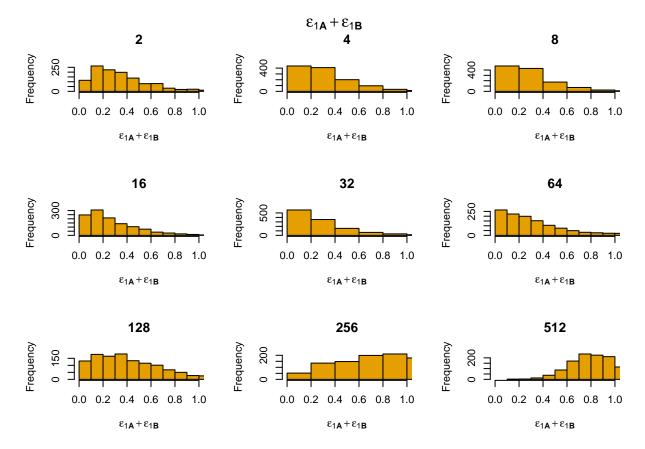


C) Extinction fractions

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

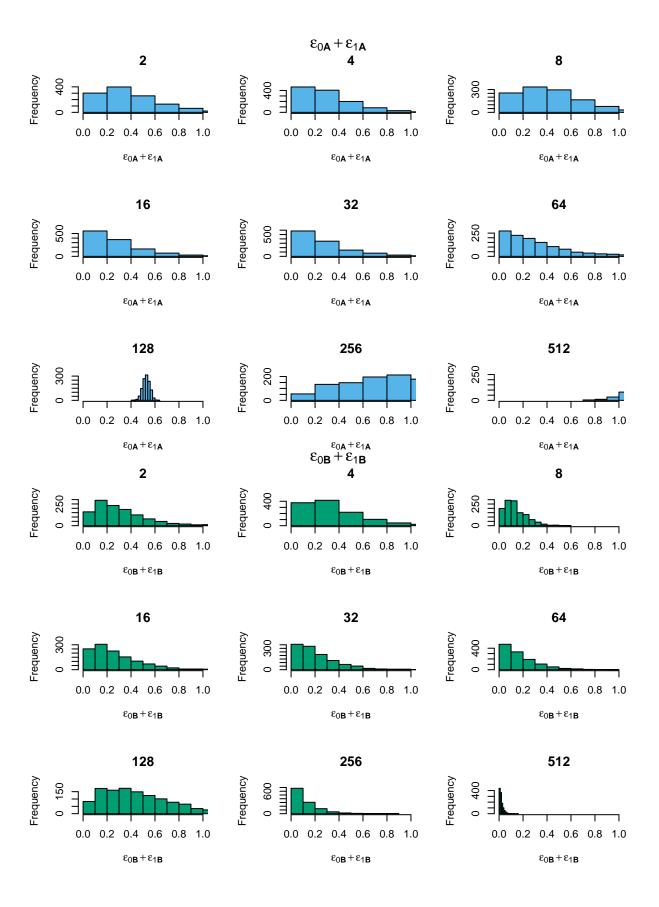
Here we are adding extinction fractions rates for state 0A and 0B into state 0 and state 1A and 1B to state 1, is that this should be similar to BiSSE if we reparameterize the BiSSE model in terms of extinction fraction such as





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

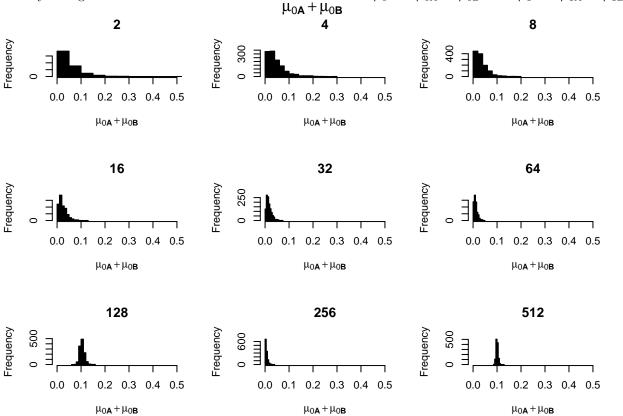
Checking if the hidden states have a signal when combining extinction fractions i.e. if the two rate classes A and B can also be combined. Here state A is represented by the sum $\epsilon_{0A} + \epsilon_{1A}$ and state B is represented by the sum $\epsilon_{0B} + \epsilon_{1B}$.

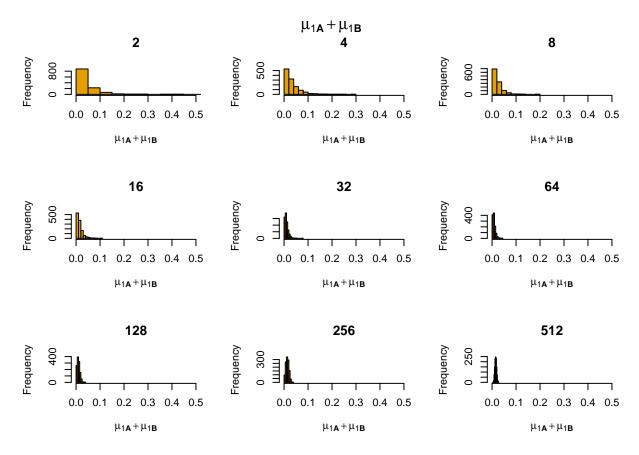


D) Extinction rates

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

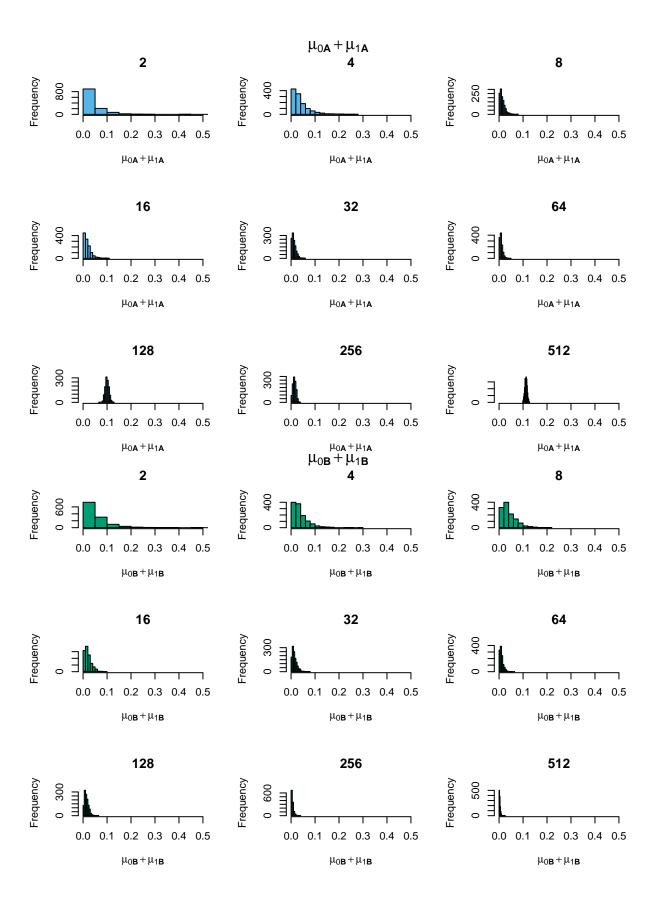
I am adding the extinction rates for state 0A and 0B into state 0 and state 1A and 1B to state 1. By doing this the model reduces to BiSSE such that $\mu_0 = \mu_{0A} + \mu_{0B}$ and $\mu_1 = \mu_{1A} + \mu_{1B}$.





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 $\mu_{0B} + \mu_{1B}$.

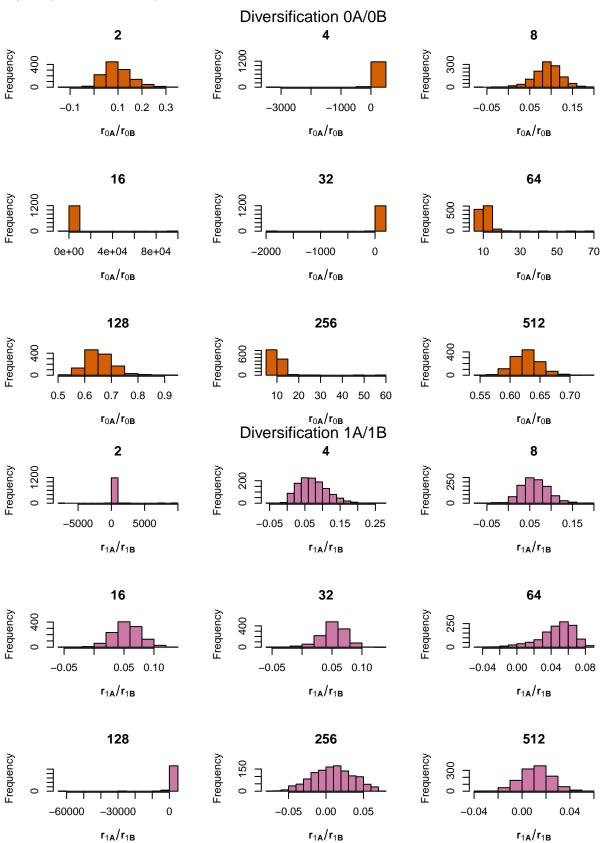


(II) Diversification rates check "r":

- 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 Diversification 0A/1A 2 8 4 Frequency 0 1200 Frequency Frequency 250 1000 3000 0 50 150 -1000 -500 500 1500 r_{0A}/r_{1A} $r_{0\text{A}}/r_{1\text{A}}$ r_{0A}/r_{1A} 16 32 64 0 1200 Frequency Frequency Frequency -2000 0 -3000 0 -10000 0 10000 -4000 -6000 25000 r_{0A}/r_{1A} r_{0A}/r_{1A} r_{0A}/r_{1A} 128 256 512 Frequency Frequency 1000 -requency 200 0.30 0.35 0.40 0.45 0e+00 2e+05 4e+05 0 5000 -5000 r_{0A}/r_{1A} Diversification 0B/1B r_{0A}/r_{1A} r_{0A}/r_{1A} 2 8 0 1200 Frequency Frequency 0 300 Frequency 0 5000 0.1 0.3 2.0 -10000 -0.1 1.0 1.5 2.5 r_{0B}/r_{1B} $r_{0\text{B}}/r_{1\text{B}}$ r_{0B}/r_{1B} 16 32 64 Frequency Frequency Frequency 300 500 0 0.1 0.2 0.3 0.05 0.15 0.05 0.10 0.15 0.20 -0.1 -0.05 0.25 $r_{0\text{B}}/r_{1\text{B}}$ $r_{0\text{B}}/r_{1\text{B}}$ $r_{0B}/r_{1B} \\$ 128 256 512 Frequency Frequency Frequency 0 500 0 250 1 -30000 -15000 0.10 0.15 0.20 0.56 0 0.05 0.48 0.52 0.60 r_{0B}/r_{1B} $r_{0\text{B}}/r_{1\text{B}}$ $r_{0\text{B}}/r_{1\text{B}}$

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



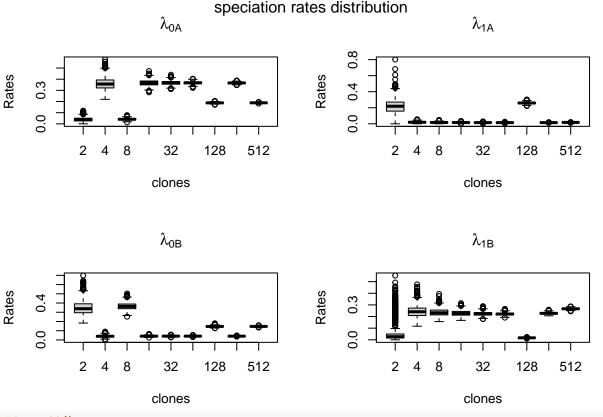
#

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 λ_{0A} , λ_{1A} , λ_{0B} , λ_{1B} and extinction rates μ_{0A} , μ_{1A} , μ_{0B} , μ_{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.

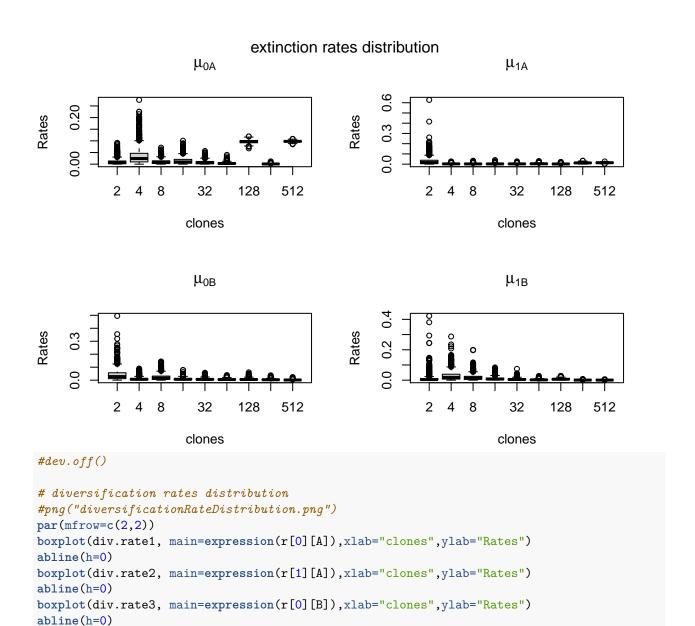
```
#Format 1=0A, 2=1A, 3=0B, 4=1B.

# 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()

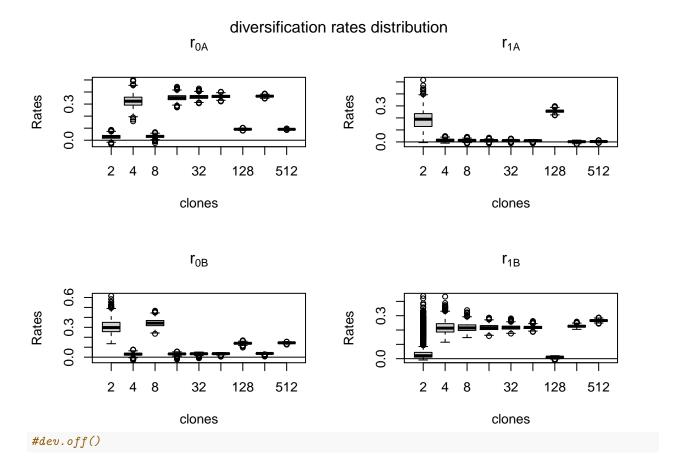
# extinction rates distribution
#png("extinctionRateDistribution.png")
par(mfrow=c(2,2))
boxplot(mu1.his.clone, main=expression(mu[0][A]),xlab="clones",ylab="Rates")
boxplot(mu2.his.clone, main=expression(mu[1][A]),xlab="clones",ylab="Rates")
boxplot(mu3.his.clone, main=expression(mu[0][B]),xlab="clones",ylab="Rates")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



boxplot(div.rate4, main=expression(r[1][B]),xlab="clones",ylab="Rates")

mtext("diversification rates distribution", side =3, line = -1.5, outer = TRUE)

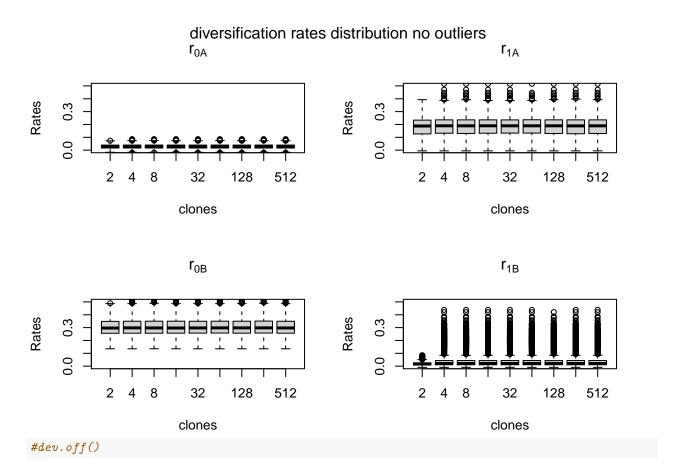
abline(h=0)



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)
```



A) r_{0A}/r_{1A} and r_0B/r_1B . - Checking convergence -Outliers removed Diversification 0A/1A - no outliers 2 8 0 1200 Frequency requency-Frequency 150 250 1000 3000 0 50 -1000 -500 500 1500 r_{0A}/r_{1A} r_{0A}/r_{1A} r_{0A}/r_{1A} 16 32 64 0 1200 -requency Frequency Frequency -4000 -2000 0 -3000 0 -10000 0 10000 -6000 25000 r_{0A}/r_{1A} r_{0A}/r_{1A} r_{0A}/r_{1A} 128 256 512 1000 Frequency -requency 200 0.30 0.35 0.40 0.45 0e+00 2e+05 4e+05 -5000 0 5000 Diversification 0B/1B – no outliers r_{0A}/r_{1A} r_{0A}/r_{1A} 2 8 Frequency 1200 Frequency Frequency 300 0 5000 0.1 0.3 1.5 2.0 -10000 -0.1 1.0 2.5 $r_{0B}/r_{1B} \\$ $r_{0\text{B}}/r_{1\text{B}}$ r_{0B}/r_{1B} 16 32 64 Frequency -requency 500 Frequency 300 0 300 0 0 0.1 0.2 0.3 0.05 0.15 0.05 0.10 0.15 0.20 -0.1 -0.05 0.25 $r_{0B}/r_{1B} \\$ $r_{0B}/r_{1B} \\$ r_{0B}/r_{1B} 128 256 512 Frequency Frequency Frequency 0 500 250 0 0 -30000 -15000 0.10 0.15 0.20 0.48 0.52 0.56 0.05 0.60

 r_{0B}/r_{1B}

 r_{0B}/r_{1B}

 $r_{0\text{B}}/r_{1\text{B}}$

B) r_{0A}/r_{0B} annd r_{1A}/r_{1B} - Checking Noise - Outliers Removed Diversification 0A/0B - no outliers 2 8 Frequency 0 1200 Frequency Frequency 0 400 0.1 0.2 0.3 -0.1 -3000 -1000 -0.05 0.05 0.15 r_{0A}/r_{0B} r_{0A}/r_{0B} $r_{0\text{A}}/r_{0\text{B}}$ 32 64 16 0 1200 0 1200 Frequency Frequency Frequency -1000 0e+00 4e+04 8e+04 -2000 10 30 50 70 $r_{0\text{A}}/r_{0\text{B}}$ r_{0A}/r_{0B} $r_{0\text{A}}/r_{0\text{B}}$ 128 256 512 Frequency Frequency -requency 400 009 0 0.6 0.7 0.8 0.9 0.5 10 20 30 40 50 60 0.55 0.60 0.65 0.70 Diversification 1A/1B - no outliers $r_{0\text{A}}/r_{0\text{B}}$ r_{0A}/r_{0B} 2 8 0 1200 Frequency Frequency Frequency 200 0 5000 0.05 -5000 -0.05 0.05 0.15 0.25 -0.050.15 $r_{1\text{A}}/r_{1\text{B}}$ r_{1A}/r_{1B} r_{1A}/r_{1B} 16 32 64 Frequency Frequency Frequency 400 0.05 0.10 0.05 0.10 -0.04 0.00 0.04 -0.05 -0.05 0.08 $r_{1\text{A}}/r_{1\text{B}}$ r_{1A}/r_{1B} $r_{1\text{A}}/r_{1\text{B}}$ 128 256 512 Frequency Frequency Frequency -30000 0.00 0.00 0.04 -60000 -0.05 0.05 -0.04 $r_{1\text{A}}/r_{1\text{B}}$ r_{1A}/r_{1B} $r_{1\text{A}}/r_{1\text{B}}$