MAthesis

Contents

Time bins (stratigraphic stages)

Table 1: Smaller time bins with age range, epoch name, mean age and corresponding sample sizes (on individual, species and genus level)

bin	EpochBins	Stages	MeanBins	nIndividuals	nSpecies	nGenera
(0,0.0117]	Modern	Modern	0.00585	252	64	17
(0.0117,0.126]	Upper Pleistocene	Upper Pleistocene	0.06885	42	16	7
(0.126,0.781]	Middle Pleistocene	Middle Pleistocene	0.45350	50	11	6
(0.781,1.81]	Lower Pleistocene	Lower Pleistocene	1.29350	49	23	11
(1.81,2.59]	Gelasian	Lower Pleistocene	2.19700	33	15	9
(2.59,3.6]	Piacencian	Upper Pliocene	3.09400	24	15	10
(3.6,5.33]	Zanclean	Lower Pliocene	4.46600	28	16	7
(5.33,7.25]	Messinian	Upper Miocene	6.28900	12	9	6
(7.25,11.6]	Tortonian	Upper Miocene	9.42700	43	19	9
(11.6,13.8]	Serravallian	Middle Miocene	12.71400	26	8	6
(13.8,16]	Langhian	Middle Miocene	14.89500	12	10	8
(16,20.4]	Burdigalian	Lower Miocene	18.20500	28	15	9
(20.4,23]	Aquitanian	Lower Miocene	21.73500	2	1	1

```
## [1] 0
```

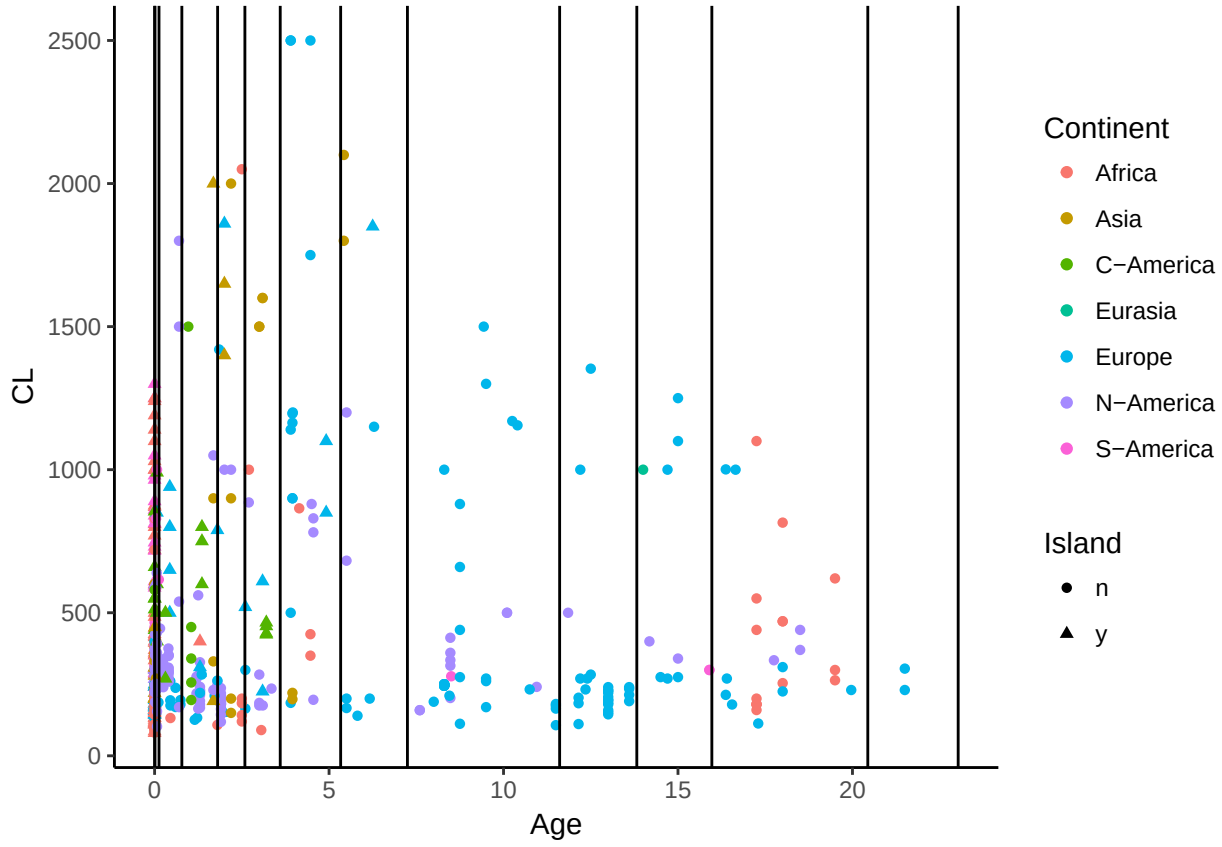


Figure 1: Scatterplot of CL over time, indicating insular (triangle) and continental (circles) and colour indicating continents. Lines indicte bins, dashed line = new bins.

Maps

fossil occurences of testudinidae

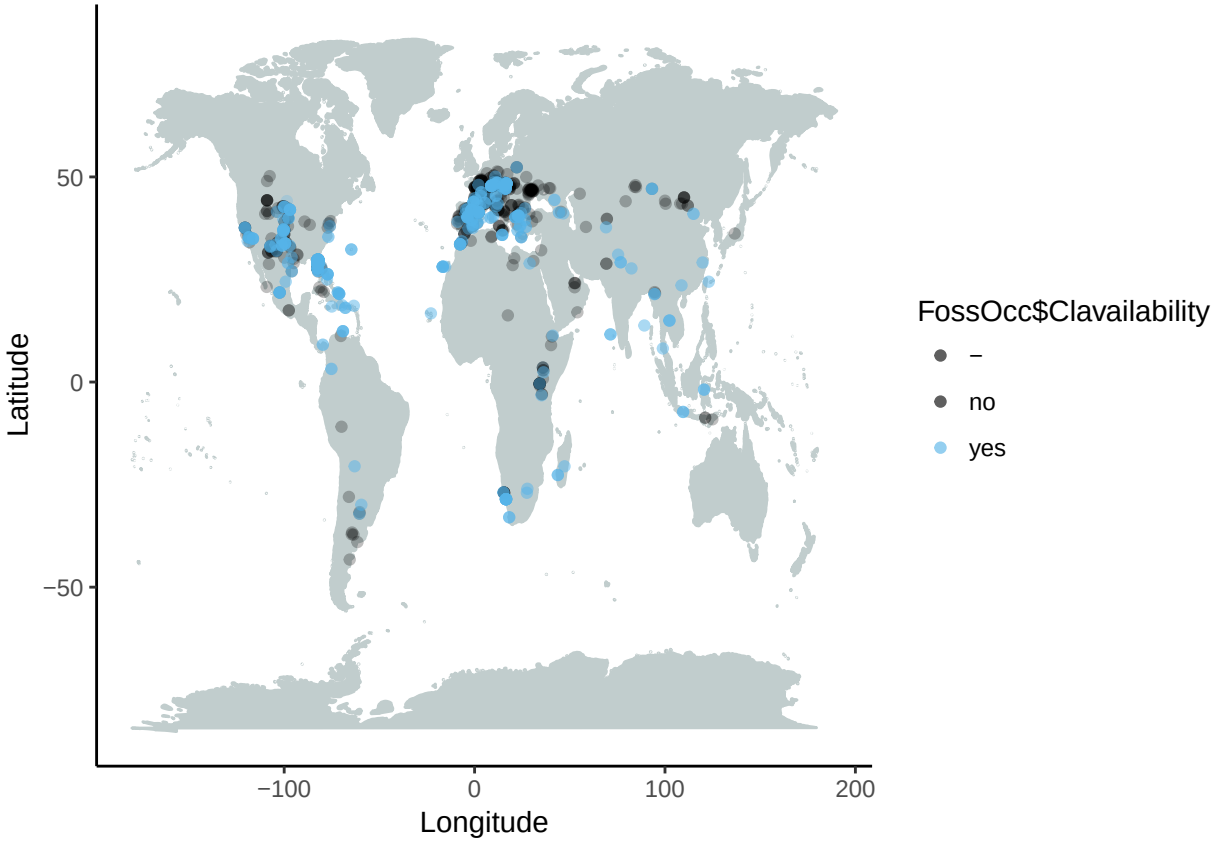


Figure 2: Map displaying all fossil occurrences of testudinids, with color indicating whether relevant literature was available (black if not) and if it was, whether body size data was available or not (yes and no, respectively).

body size of testudinidae

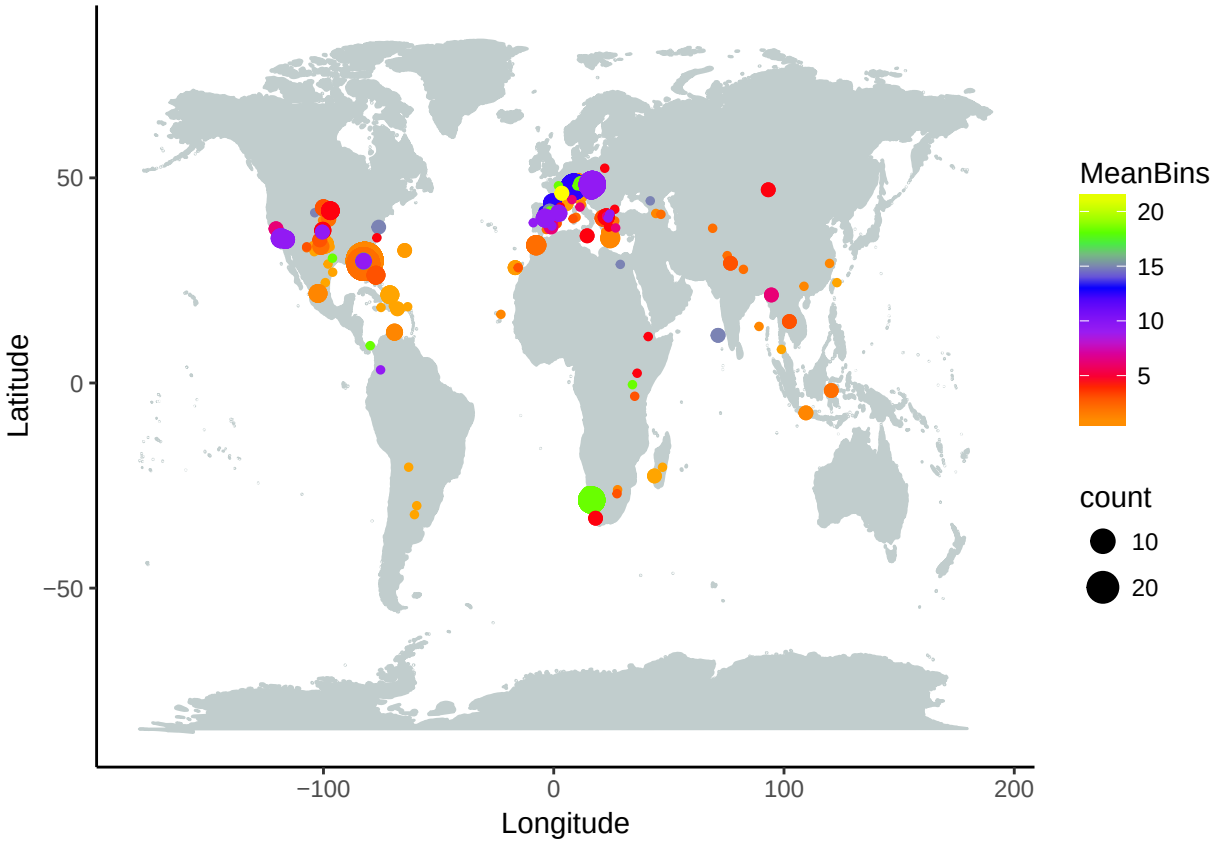
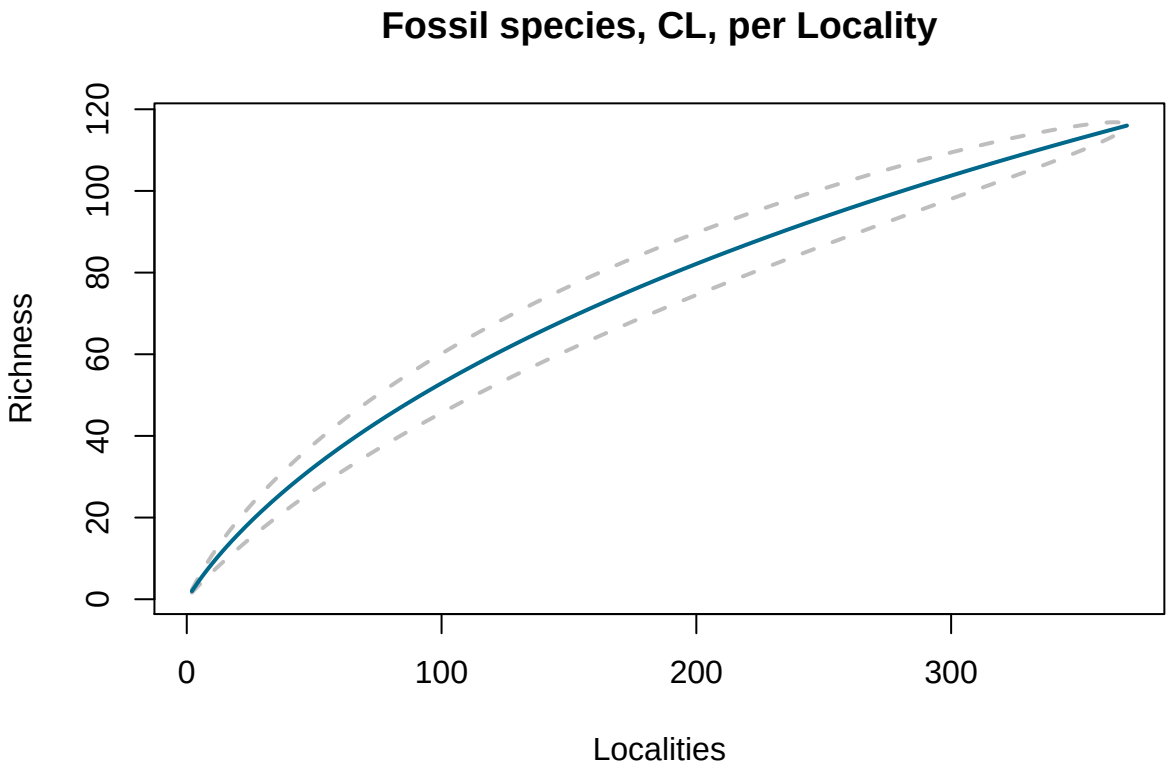
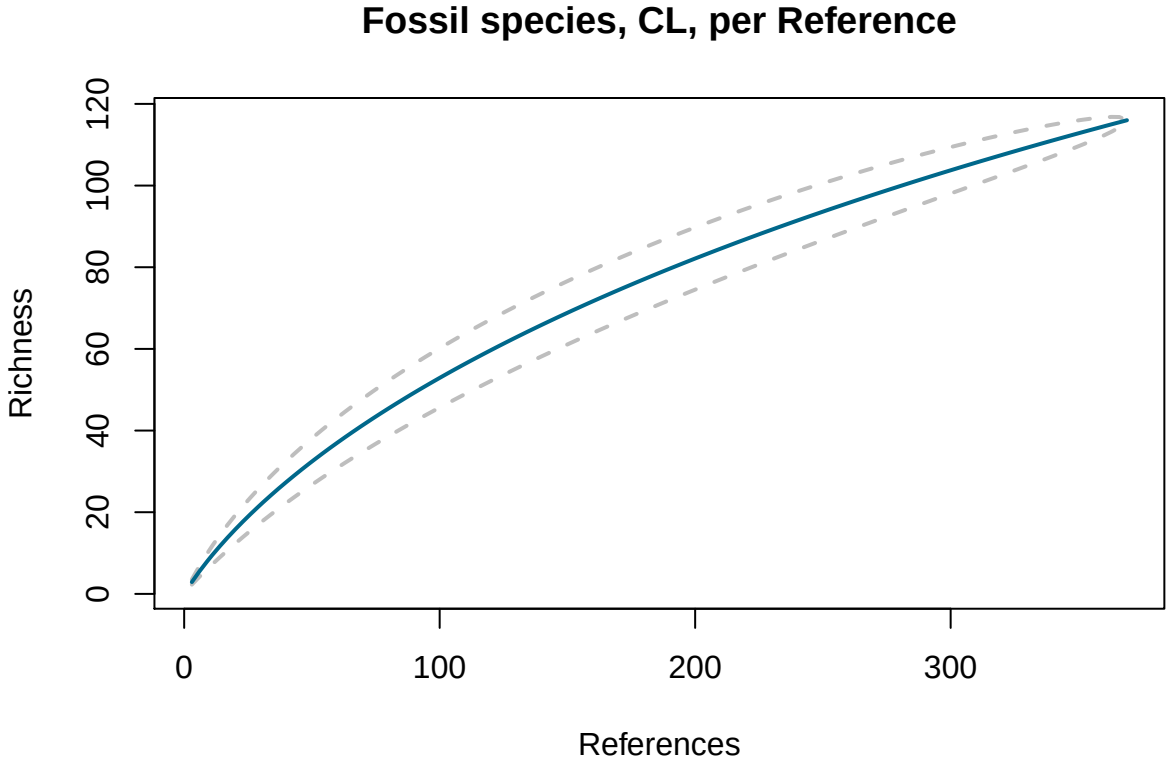


Figure 3: Map displaying all localities for which body size data for testudinids was available in the literature. Size of points denotes sample size, color denotes approximate age.

Sampling Accumulation Curves





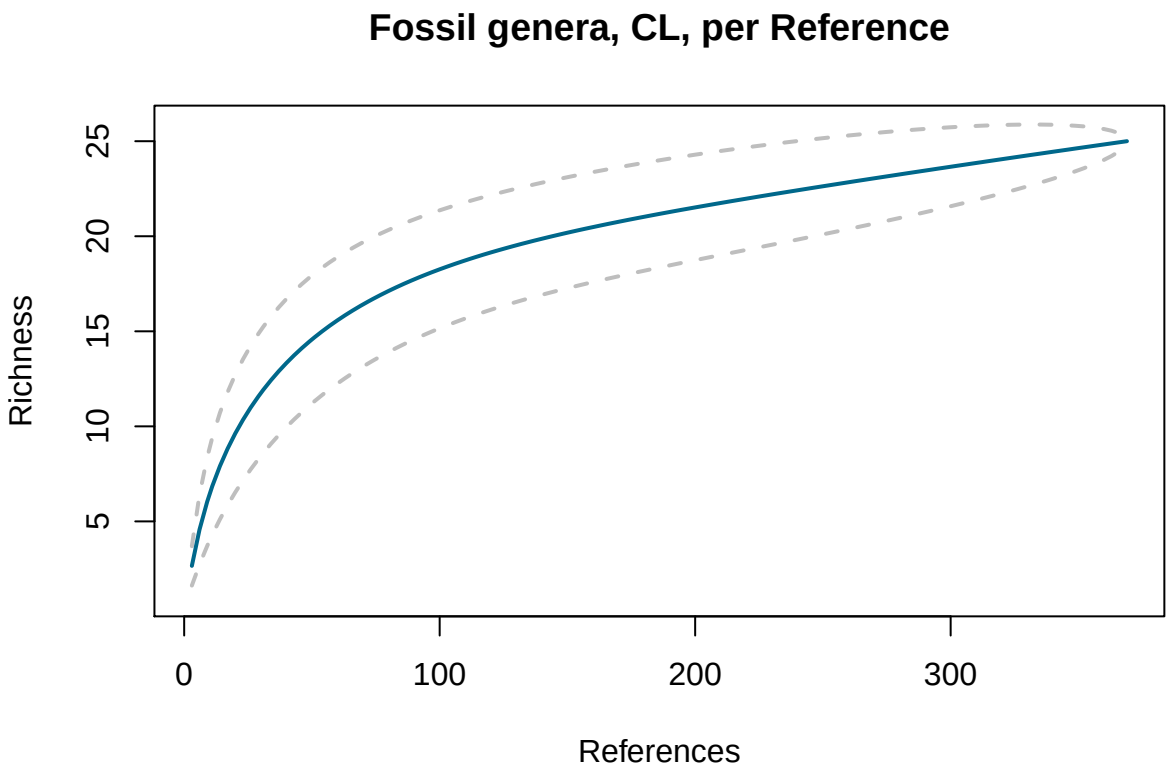


Figure 4: Sampling Accumulation Curve of fossil genera per reference

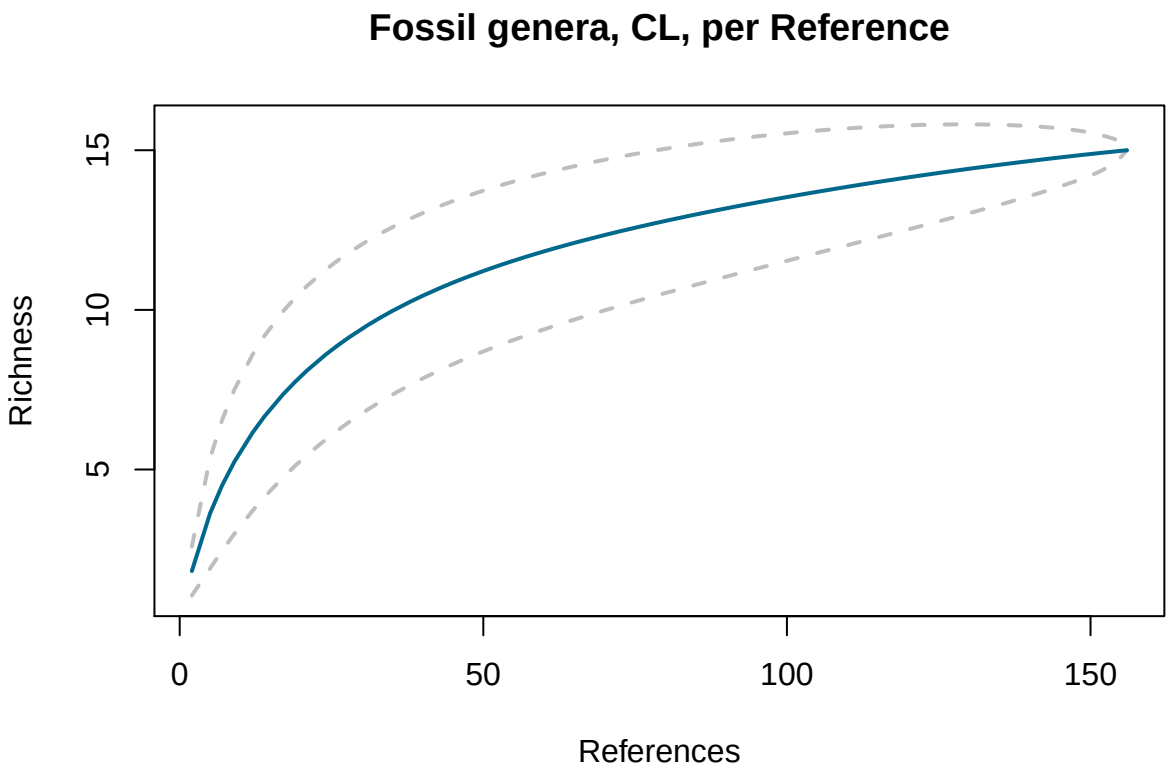


Figure 5: Sampling Accumulation Curve of fossil genera per reference, Eurasia

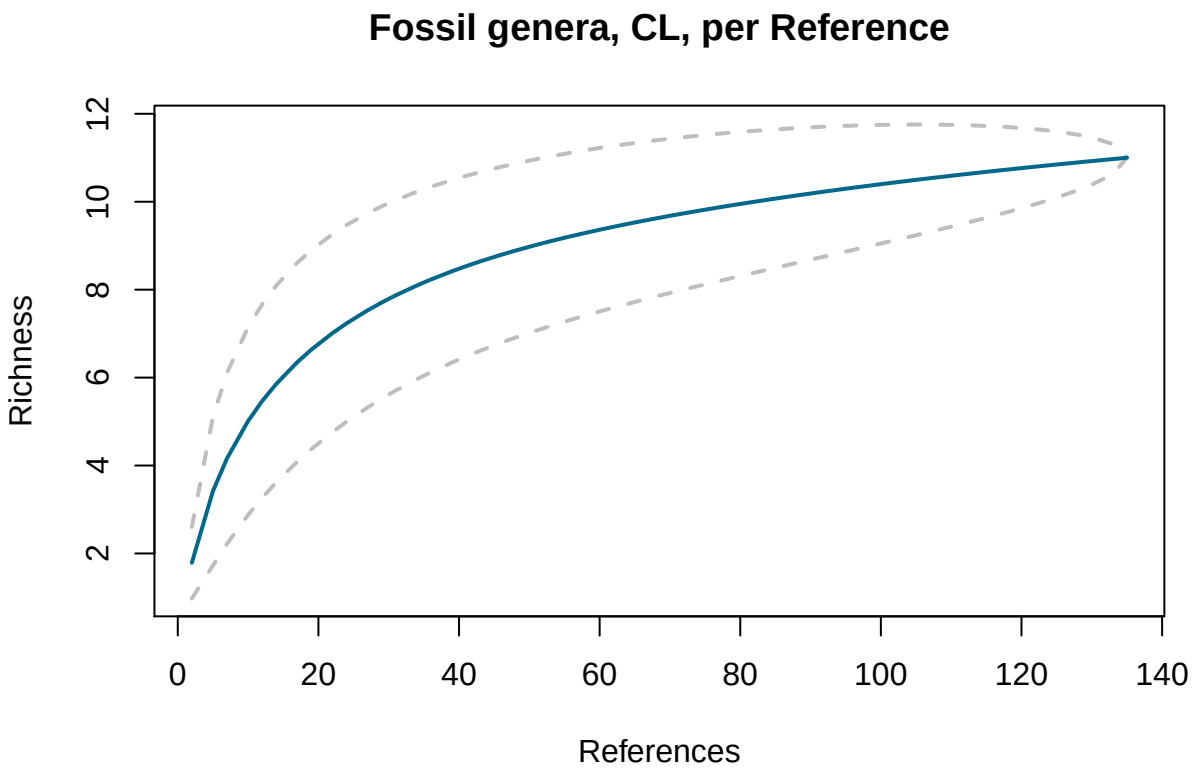


Figure 6: Sampling Accumulation Curve of fossil genera per reference, Europe

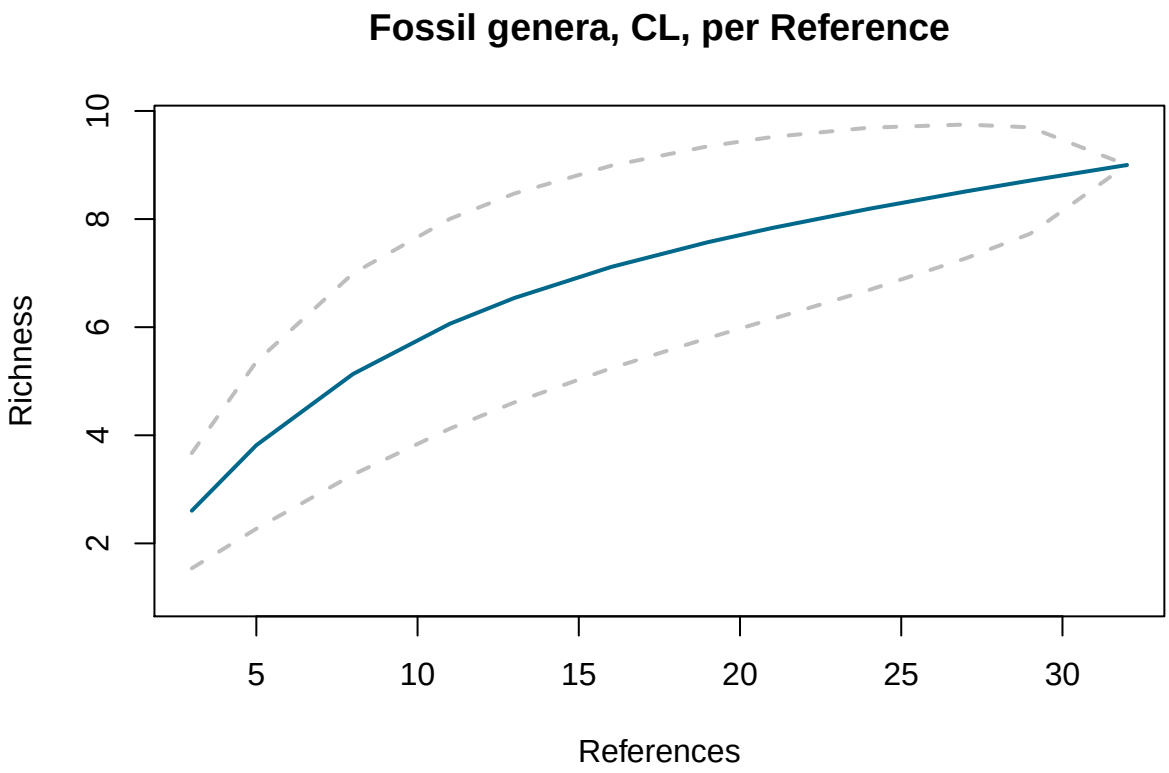


Figure 7: Sampling Accumulation Curve of fossil genera per reference, Africa

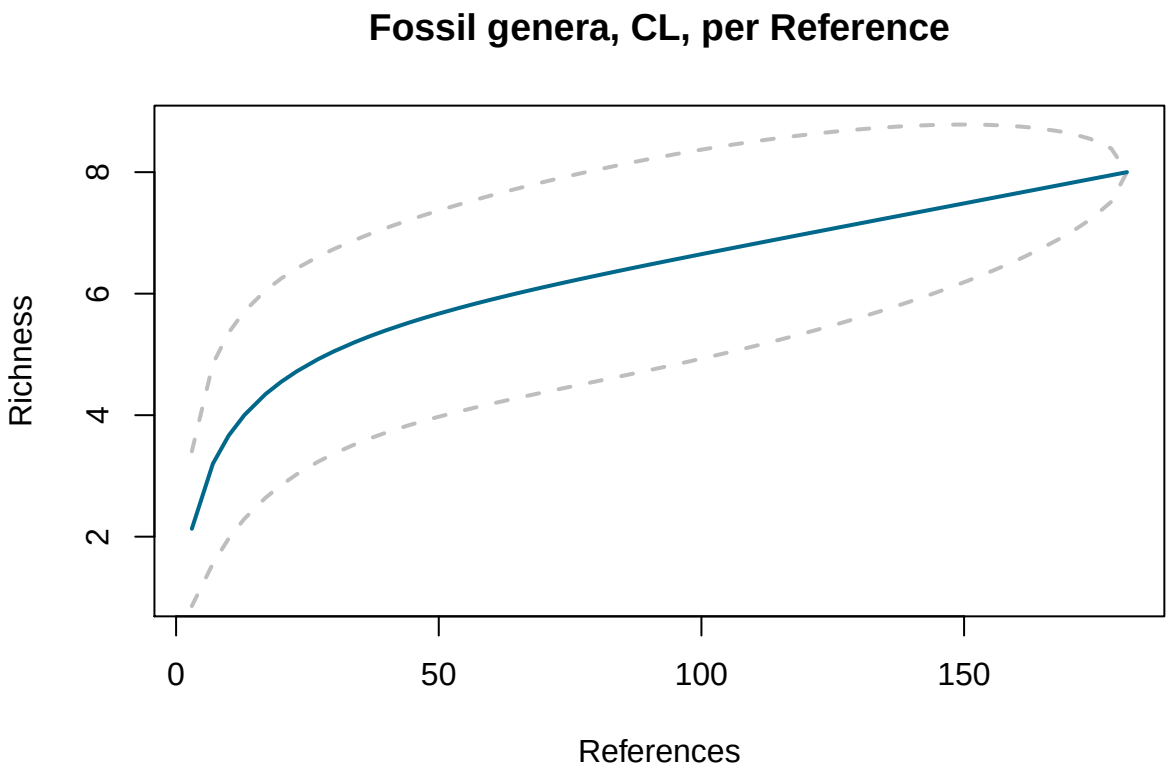


Figure 8: Sampling Accumulation Curve of fossil genera per reference, America

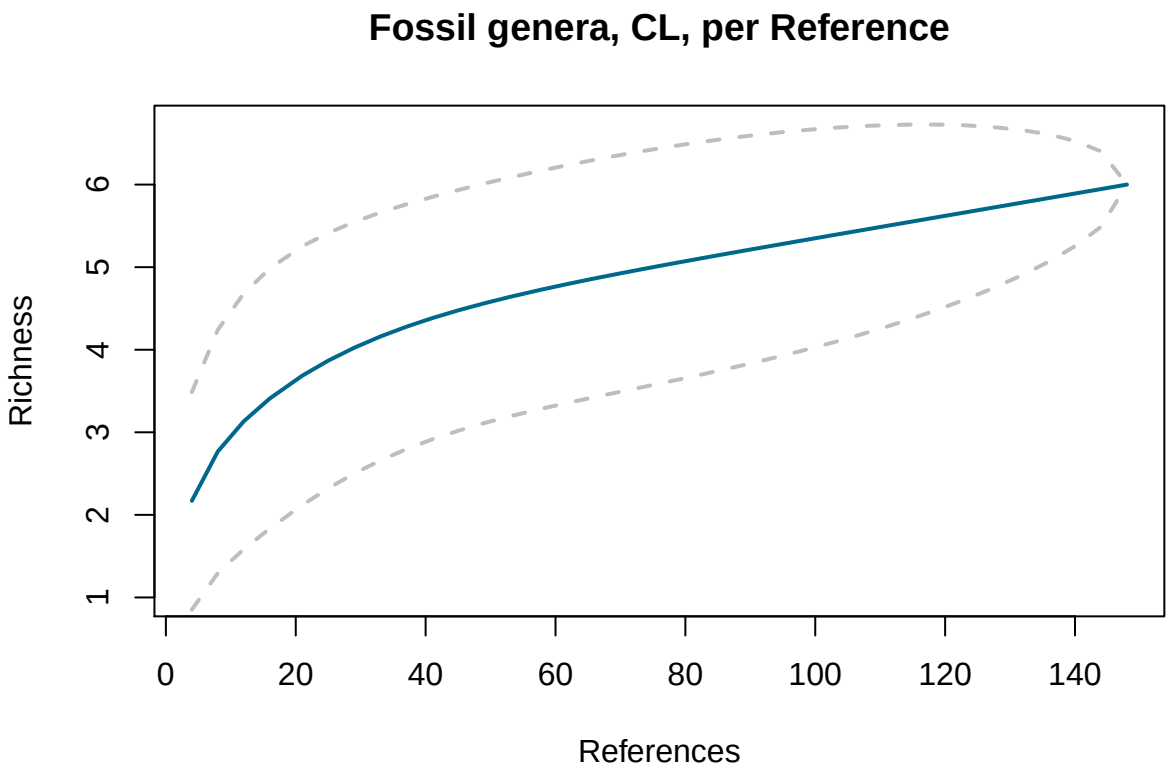


Figure 9: Sampling Accumulation Curve of fossil genera per reference, N-America

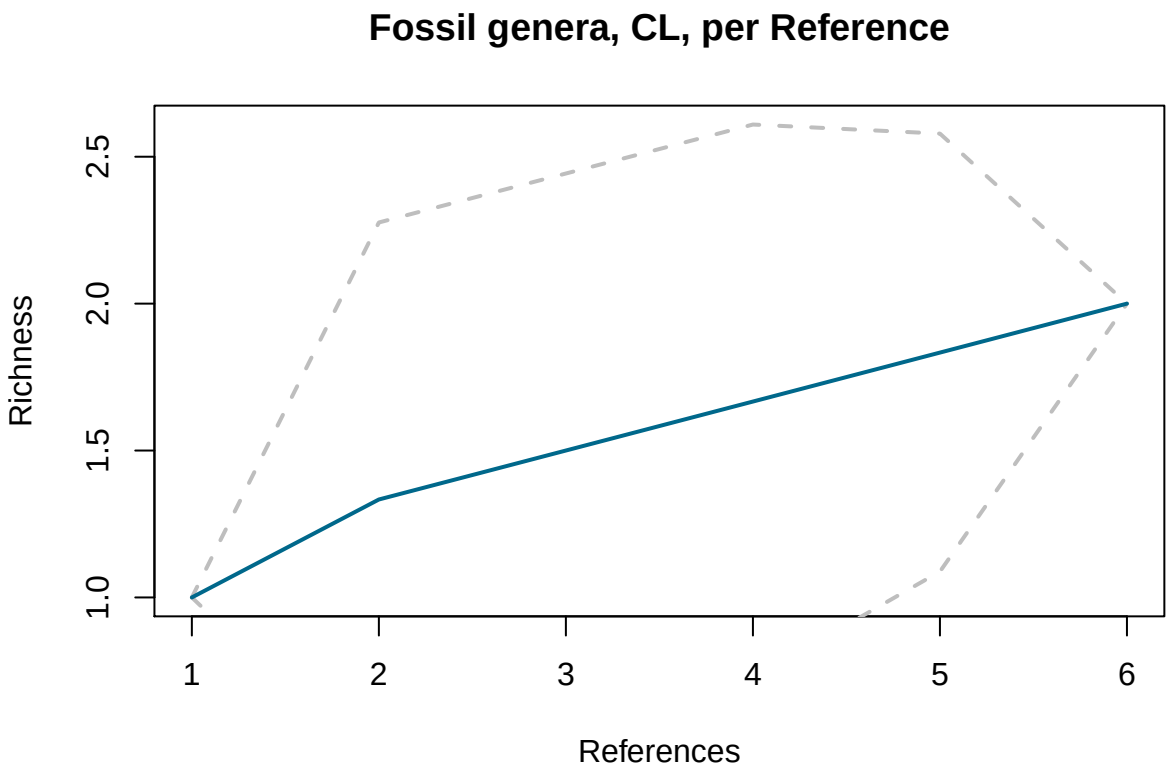


Figure 10: Sampling Accumulation Curve of fossil genera per reference, S-America

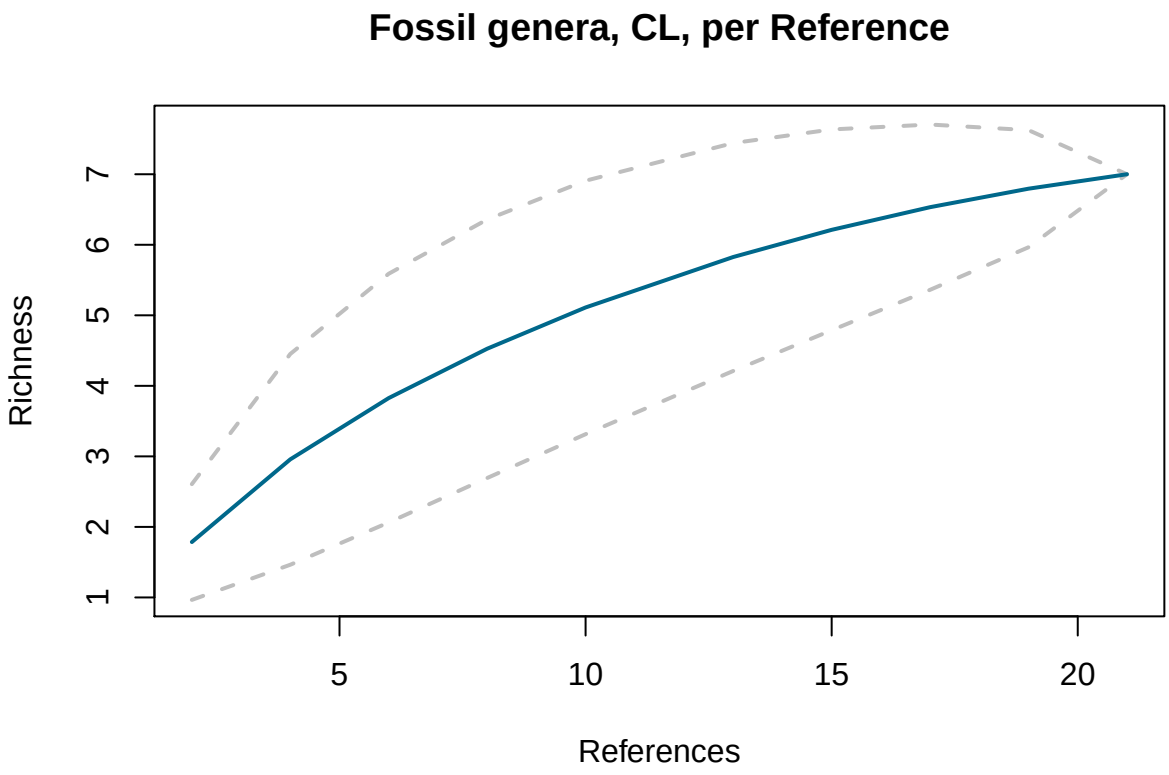


Figure 11: Sampling Accumulation Curve of fossil genera per reference, Asia

Histograms

all

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

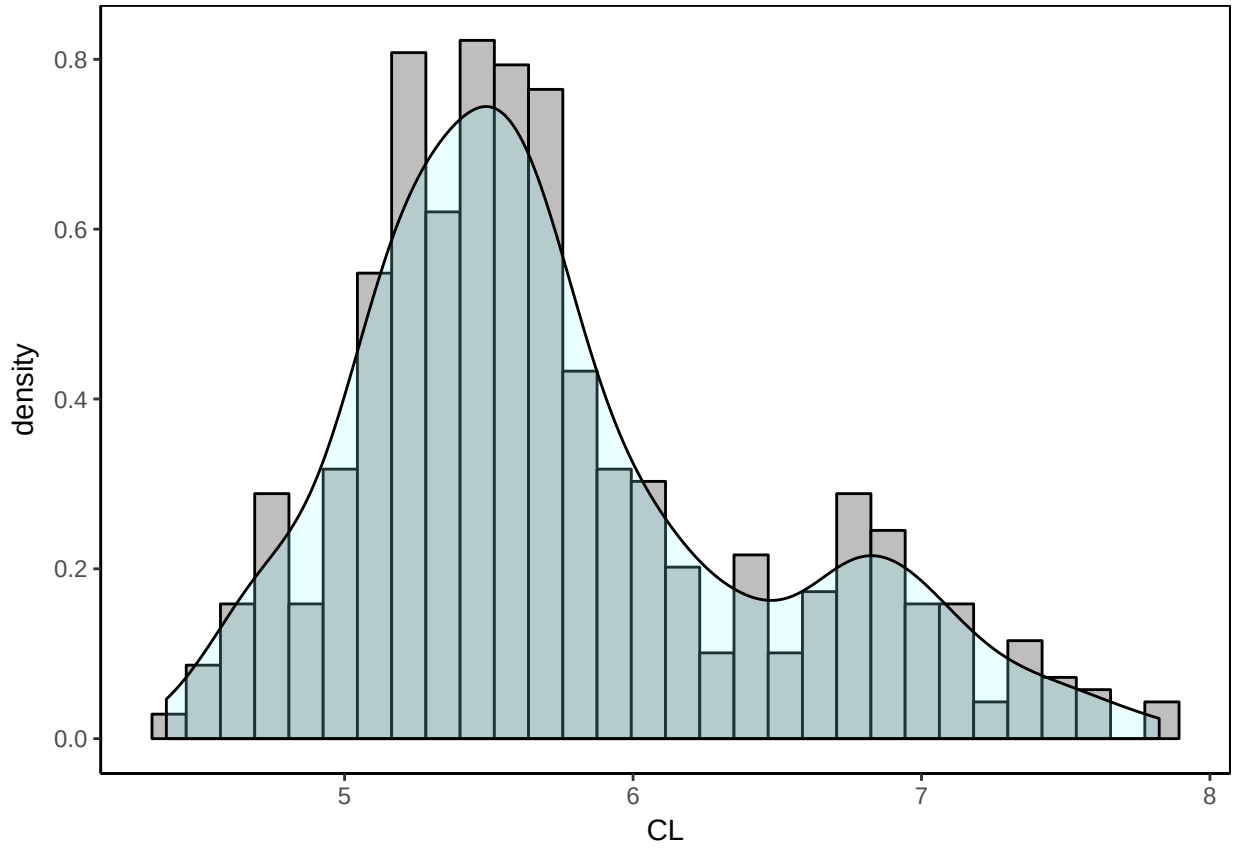
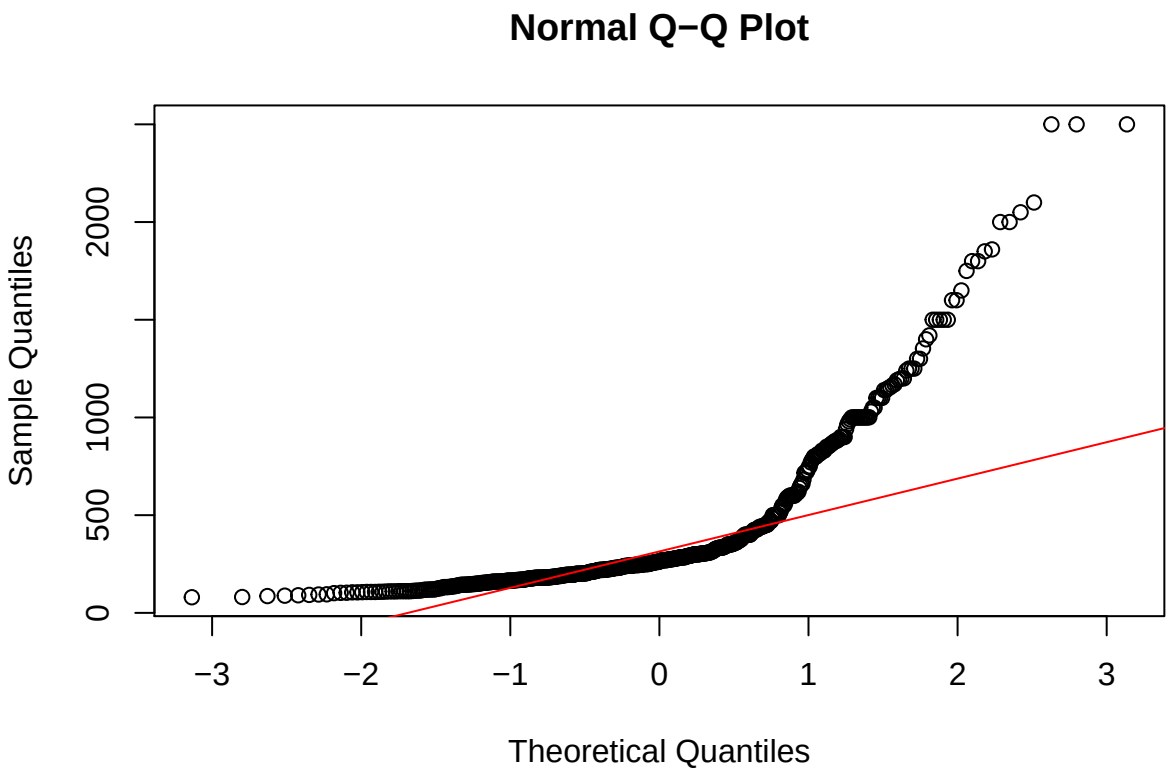
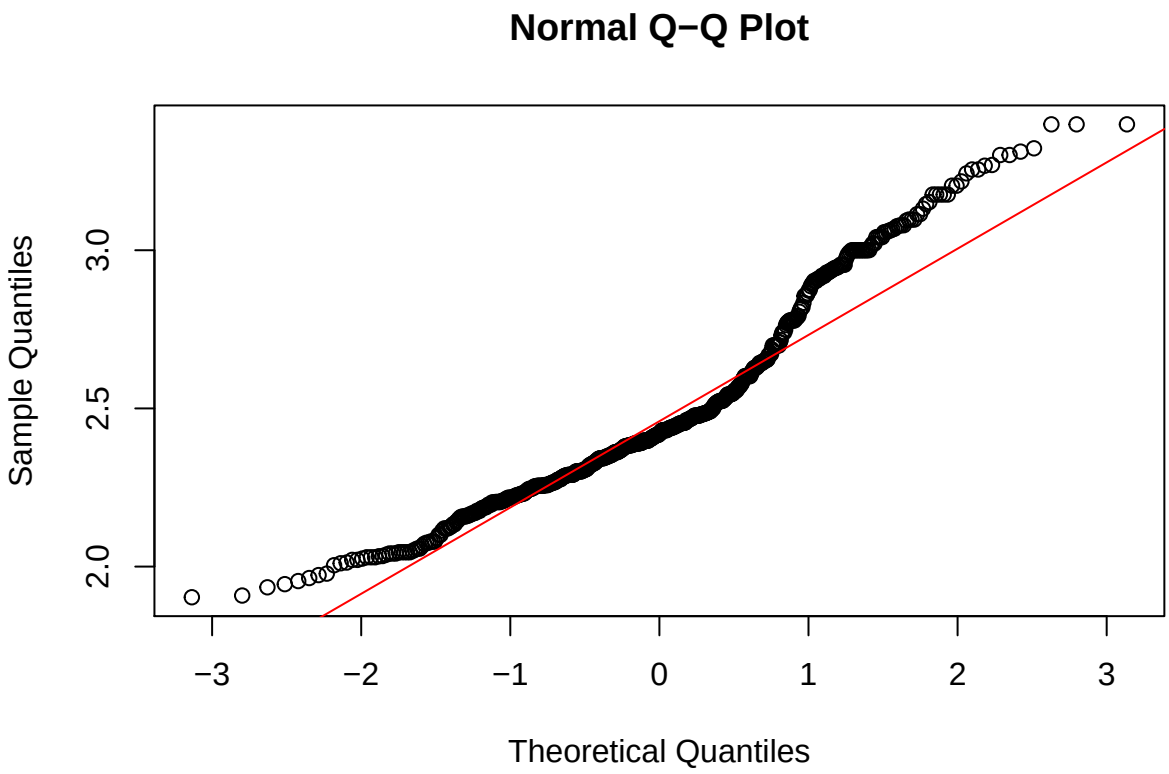


Figure 12: Distribution of body size data, logtransformed, all data.

```
qqnorm(PleiPlioCL$CL); qqline(PleiPlioCL$CL, col=2)
```




```
qqnorm(log10(PleiPlioCL$CL)); qqline(log10(PleiPlioCL$CL), col=2)
```


Normal Q−Q Plot
Sample Quantiles
2.0
2.5
3.0
−3
−2
−1
0
1
2
3
Theoretical Quantiles

per time bin

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

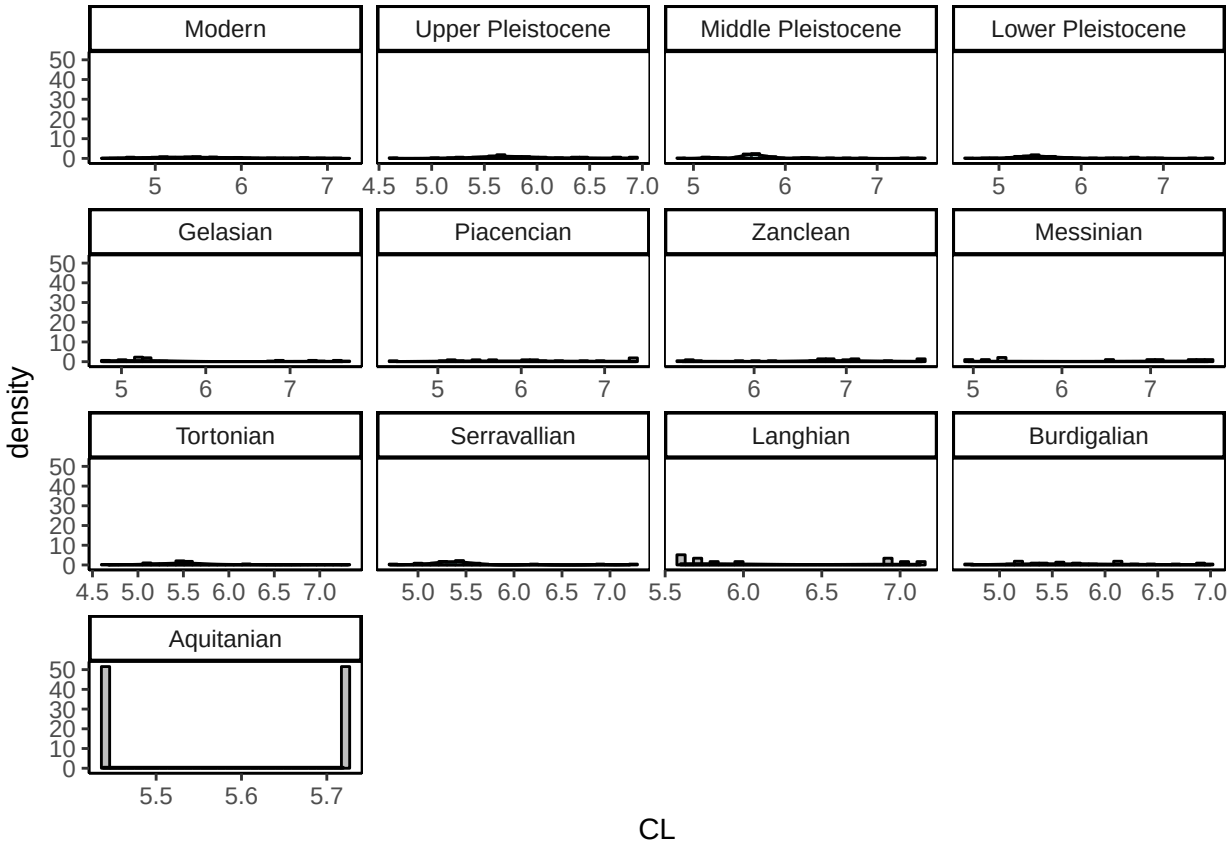


Figure 13: Distribution of body size data per time bin, logtransformed.

modern vs. fossil

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

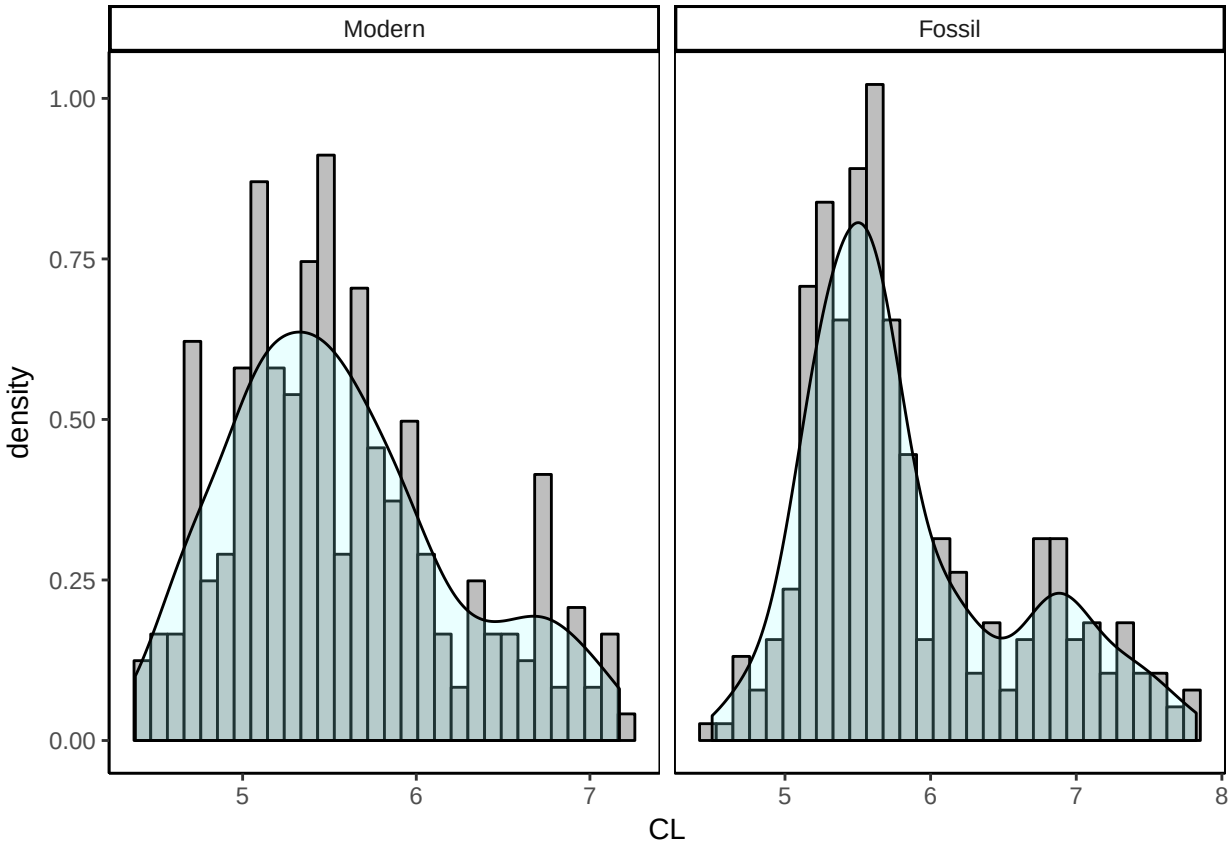


Figure 14: Distribution of body size data modern vs. fossil, logtransformed.

modern vs. fossil, continental vs. insular

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

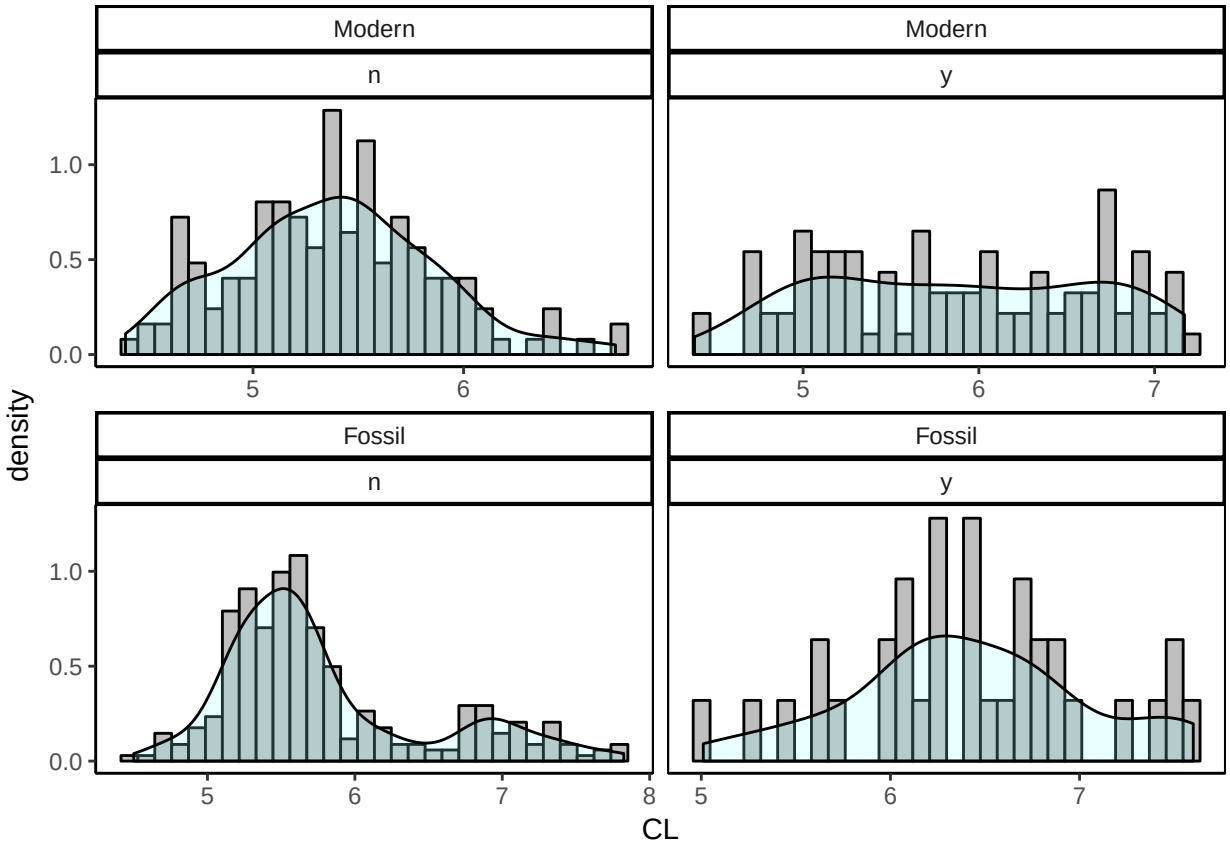


Figure 15: Distribution of body size data modern vs. fossil, continental vs. insular logtransformed.

continental vs. insular

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

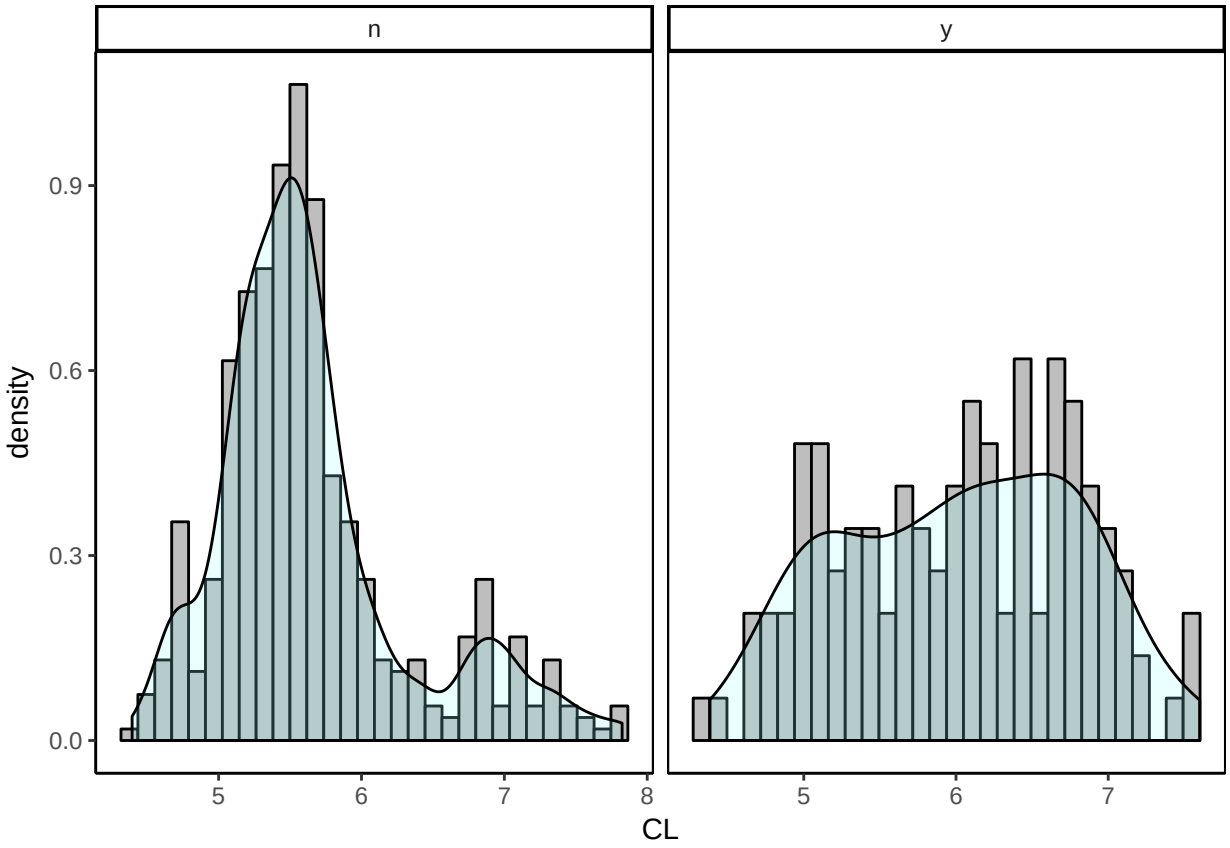


Figure 16: Distribution of body site data of continental (n) and insular(y) species, logtransformed.

continents

```
## `stat_bin()` using `bins = 30`. Pick better value with `binwidth`.
```

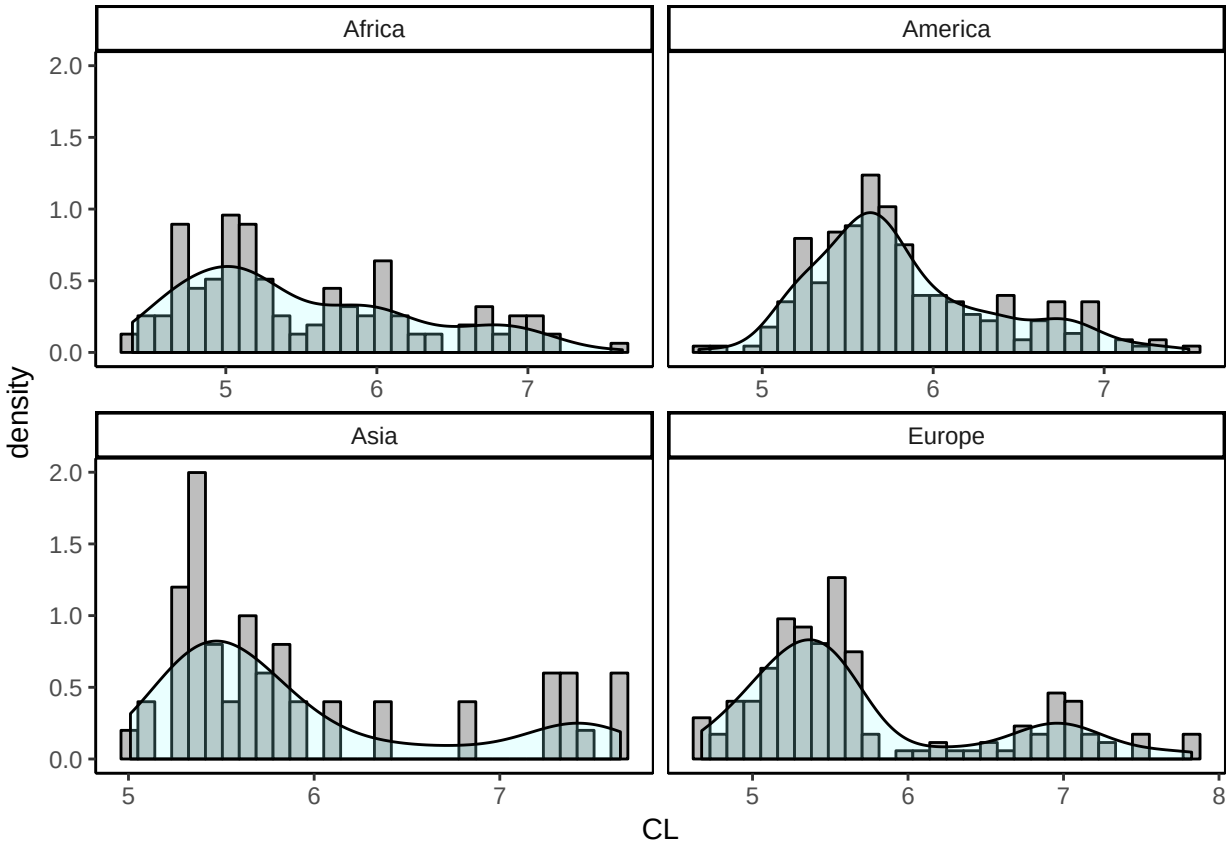


Figure 17: Distribution of body site data per continent, logtransformed.

General statistics

Table 2: General statistics of body size data: all, per time bin, insular and continental, per continent (all referring to CL: min, max, variance, mean, logmean, median, logmedian, skewness, logskewness, kurosis, logkurtosis

nCL	min	max	var	mean	logm	med	logmed	skew	logsk	kurt	logku	Variable
584	80.00	2500.0	153033.215	412.6	2.5	263.5	2.4	2.43	0.79	9.69	3.06	all
251	80.00	1300.0	67983.686	330.9	2.4	242.0	2.4	1.82	0.58	5.81	2.67	Modern
41	102.44	1000.0	46837.332	384.7	2.5	302.4	2.5	1.52	0.38	4.59	3.21	Upper Pleistocene
50	132.00	1800.0	91702.937	376.2	2.5	292.5	2.5	3.34	1.59	14.51	6.20	Middle Pleistocene
49	107.80	2000.0	127763.307	378.1	2.5	241.9	2.4	2.84	1.28	11.59	4.24	Lower Pleistocene
31	118.90	2050.0	411224.514	555.2	2.5	194.9	2.3	1.31	0.93	3.12	2.11	Gelasian
21	90.00	1600.0	270535.824	610.6	2.6	428.0	2.6	1.00	0.14	2.50	1.99	Piacencian
23	185.00	2500.0	507470.778	1005.6	2.9	880.0	2.9	0.99	-0.43	3.20	2.31	Zanclean
10	140.00	2100.0	602611.211	948.9	2.8	916.0	2.9	0.26	-0.22	1.49	1.29	Messinian
42	107.00	1500.0	118610.564	396.0	2.5	250.0	2.4	1.90	0.98	5.47	3.22	Tortonian
26	111.00	1353.0	74989.658	293.0	2.4	216.5	2.3	3.04	1.98	11.22	6.80	Serravallian
11	270.00	1250.0	159956.401	591.8	2.7	339.9	2.5	0.63	0.51	1.55	1.39	Langhian
27	113.00	1100.0	77522.797	402.5	2.5	300.0	2.5	1.33	0.46	3.66	2.31	Burdigalian
2	230.00	304.7	2790.045	267.4	2.4	267.4	2.4	0.00	0.00	1.00	1.00	Aquitanian
251	80.00	1300.0	67983.686	330.9	2.4	242.0	2.4	1.82	0.58	5.81	2.67	Modern
333	90.00	2500.0	208680.536	474.3	2.5	276.6	2.4	2.16	0.89	7.56	2.91	Fossil
453	81.00	2500.0	144546.991	375.3	2.5	247.0	2.4	2.94	1.12	12.66	4.09	continental
131	80.00	2000.0	162036.566	541.8	2.6	428.0	2.6	1.26	-0.10	4.57	2.03	insular
155	81.00	830.0	17225.925	243.8	2.3	220.0	2.3	1.91	0.31	8.00	2.96	modern-con
96	80.00	1300.0	118641.090	471.5	2.6	353.0	2.5	0.82	0.01	2.47	1.77	modern-ins
298	90.00	2500.0	197345.521	443.7	2.5	269.4	2.4	2.37	1.07	8.72	3.35	fossil-con
35	150.00	2000.0	235772.643	734.8	2.8	600.0	2.8	1.30	-0.01	3.86	2.70	fossil-ins
140	80.00	2050.0	105257.443	340.4	2.4	188.5	2.3	2.14	0.68	8.46	2.48	Africa
229	102.44	1800.0	73564.950	397.4	2.5	299.0	2.5	2.16	0.82	8.33	3.21	America
55	150.00	2100.0	334297.880	558.7	2.6	276.0	2.4	1.56	1.07	3.87	2.66	Asia

nCL	min	max	var	mean	logm	med	logmed	skew	logsk	kurt	logku	Variable
160	107.00	2500.0	236553.432	447.5	2.5	240.9	2.4	2.23	1.04	8.06	2.91	Europe

Boxplots

genera per time bins

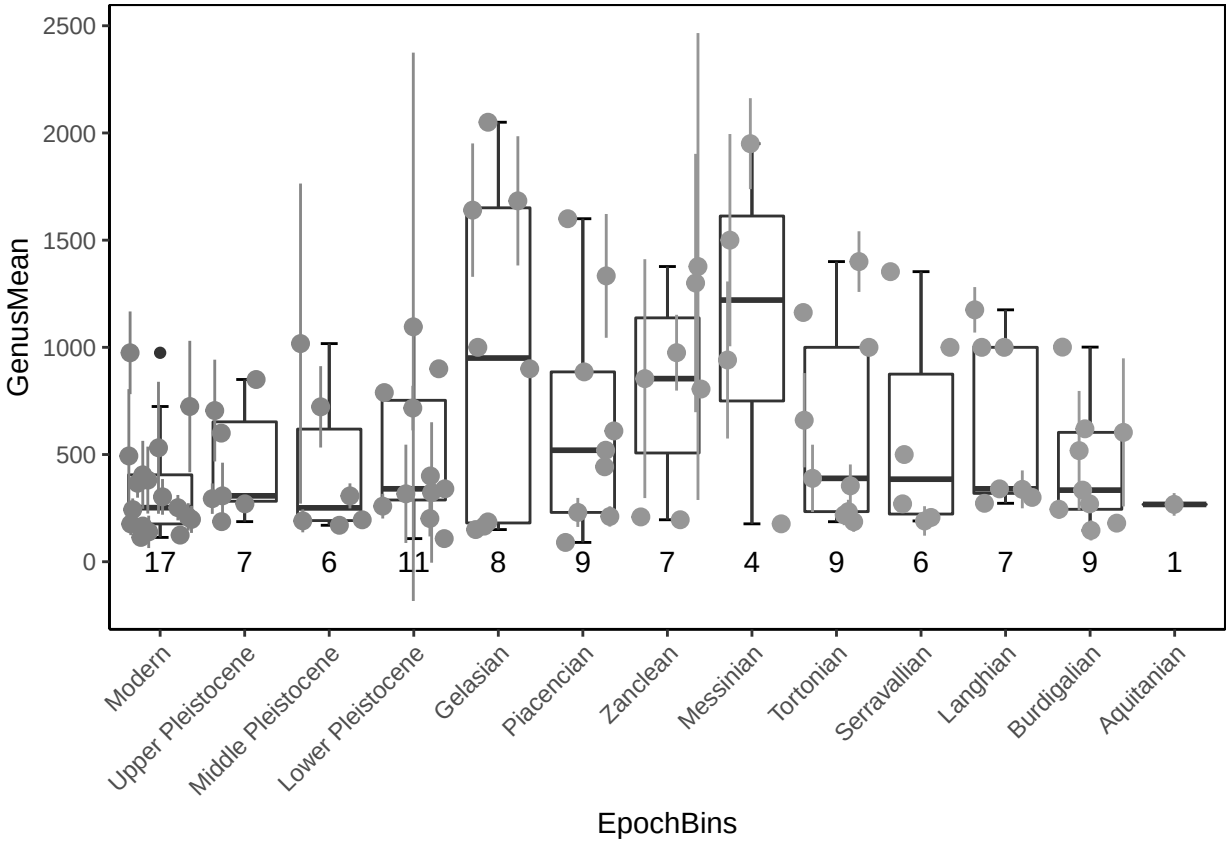


Figure 18: Boxplots of mean CL per time bin, including mean and sd CL for each genus (as pointrange).

continental vs. insular per time bin

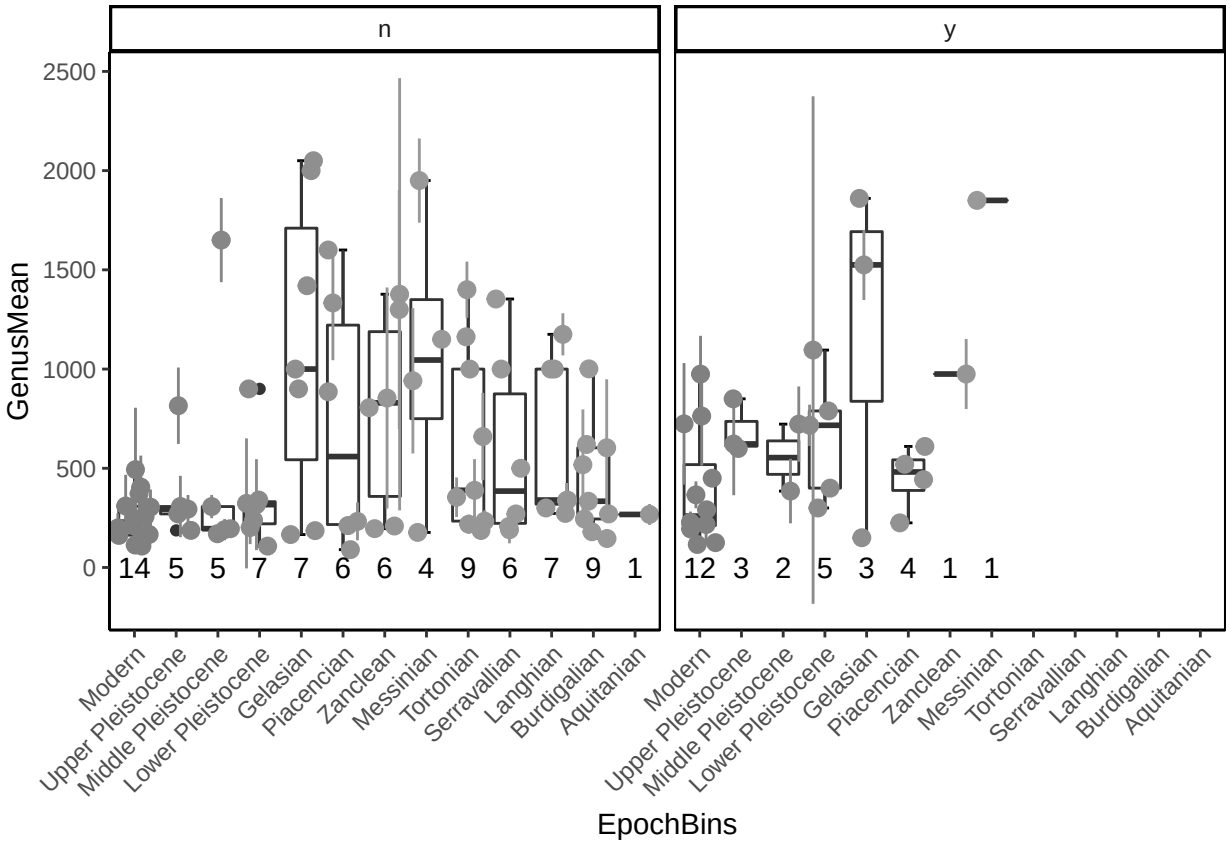


Figure 19: Boxplots of each genus per time bin, continental vs. insular species.

fossil vs. modern

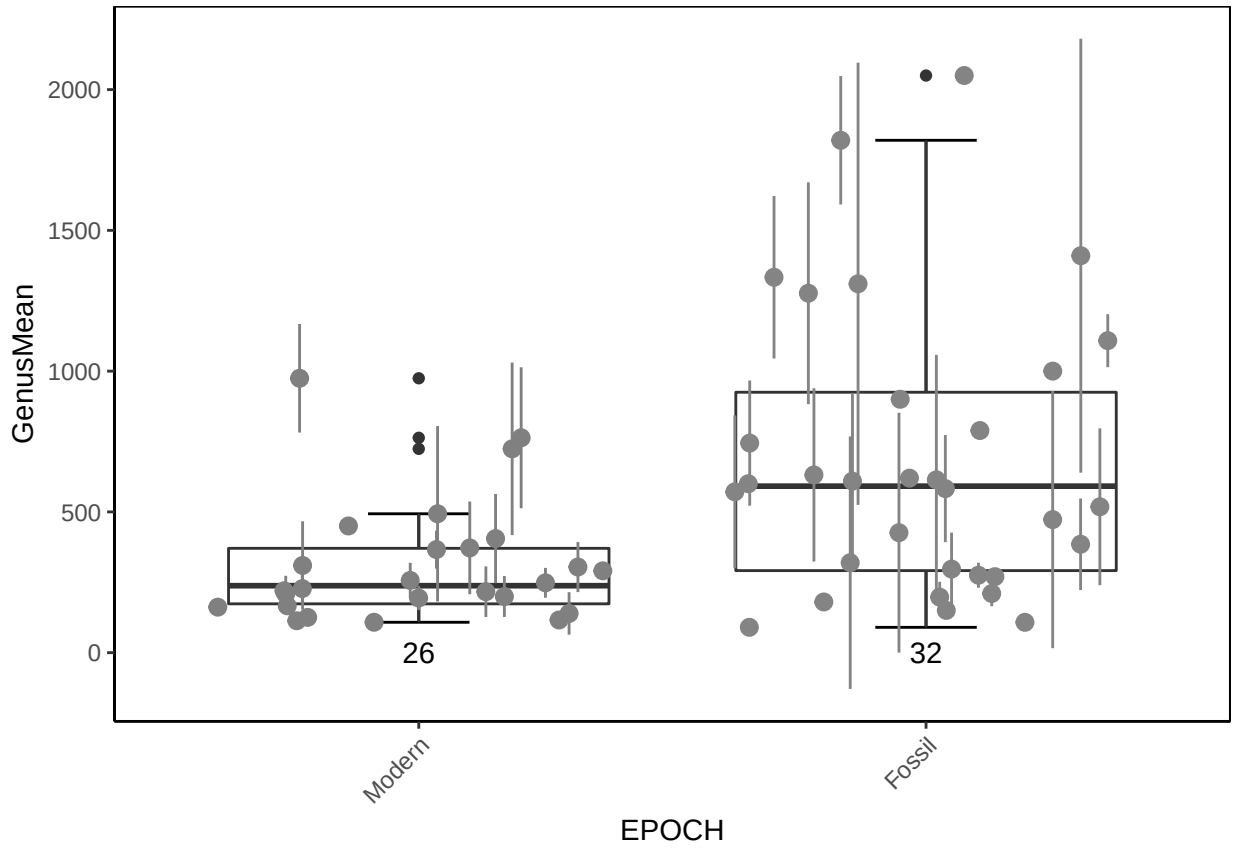
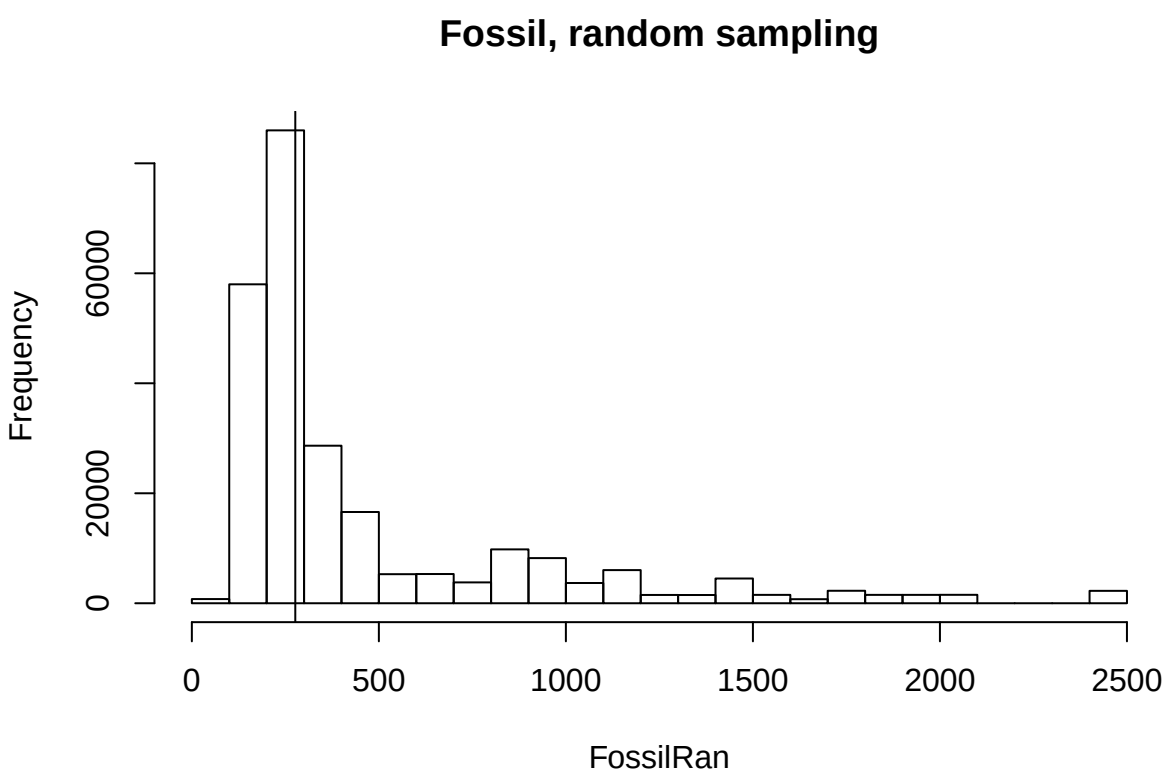


Figure 20: Boxplots fossil vs. modern.




```
## [1] 330.918
```

```
## [1] 472.8453
```

```
##
```

```
##  Wilcoxon rank sum test with continuity correction
```

```
##
```

```
## data:  Modern and Fossil
```

```
## W = 24844, p-value = 2.105e-05
```

```
## alternative hypothesis: true location shift is less than 0
```

Wilcoxon Rank Sum Test (unpaired data):

modern $<$ fossil ($\mathrm{P} = 2.1050064 \times 10^{-5}$)

fossil vs. modern, continental vs. insular

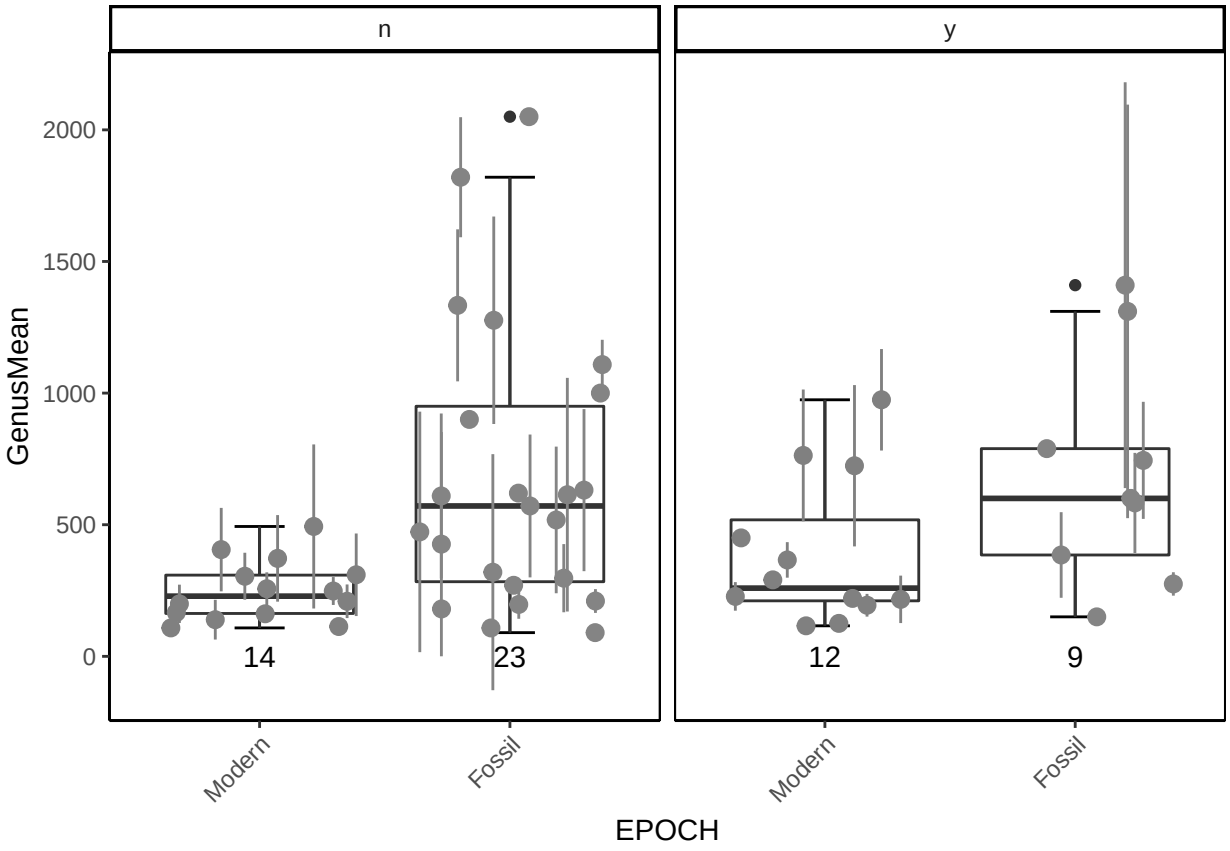
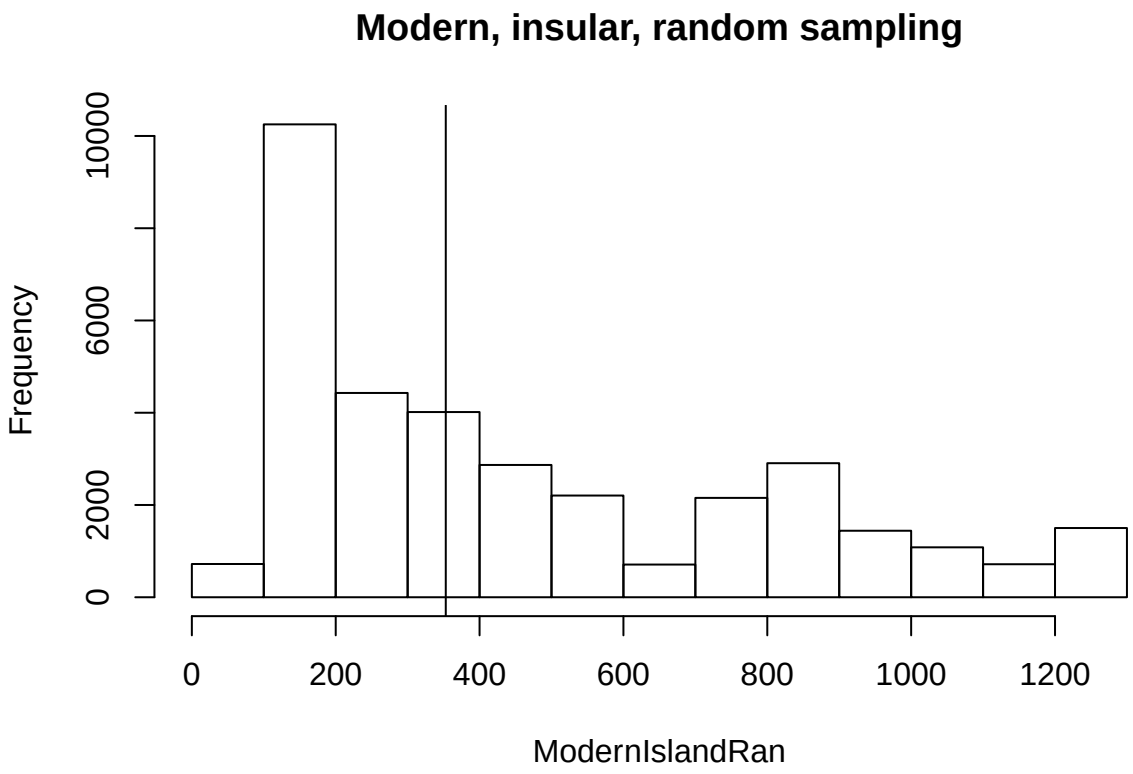


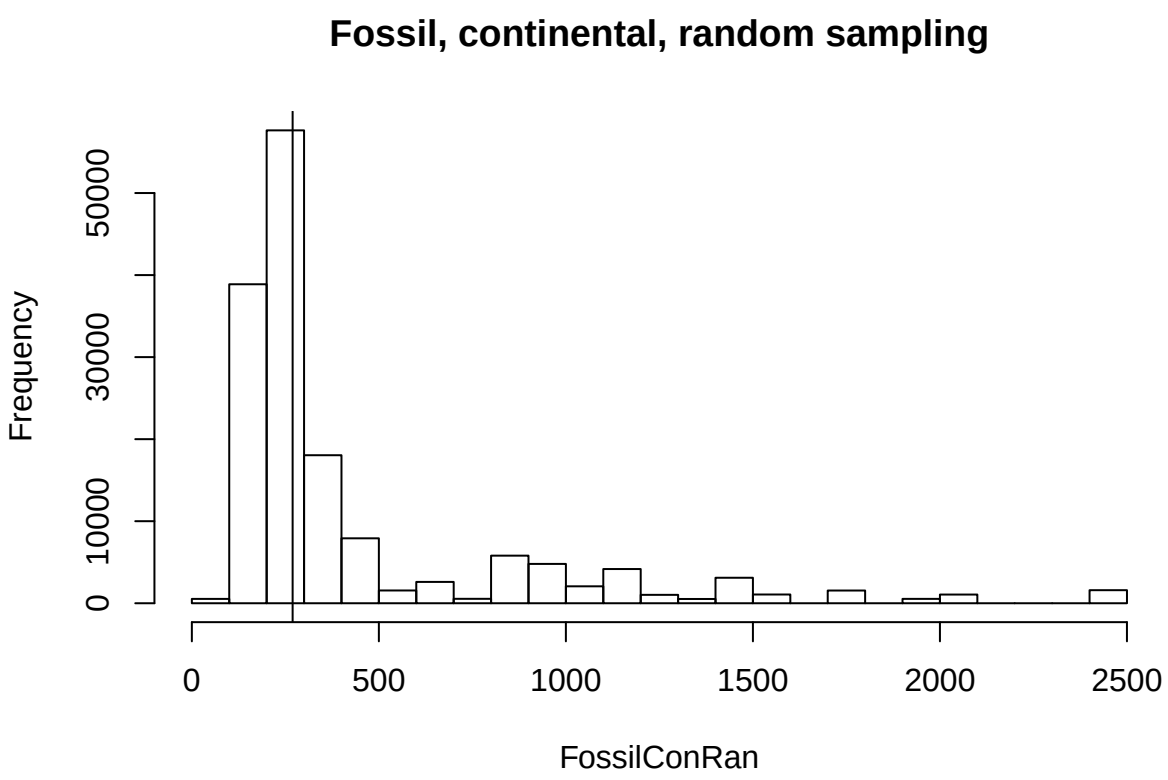
Figure 21: Boxplots fossil vs. modern, continental vs. insular species.

```
## [1] 35
```

```
## [1] 35
```




```
## Warning in wilcox.test.default(ModernIsland, FossilIsland, alternative =
## "l", : cannot compute exact p-value with ties

##
##  Wilcoxon rank sum test with continuity correction
##
## data:  ModernIsland and FossilIsland
## W = 425.5, p-value = 0.01423
## alternative hypothesis: true location shift is less than 0

## [1] 155

## [1] 155
```




```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  ModernCon and FossilCon
## W = 8619.5, p-value = 8.563e-06
## alternative hypothesis: true location shift is less than 0
```

Wilcoxon Rank Sum Test (unpaired data):

modern continental < fossil continental ($P = 8.5628365 \times 10^{-6}$)

modern insular < fossil insular ($P = 0.0142269$)

continental vs. insular

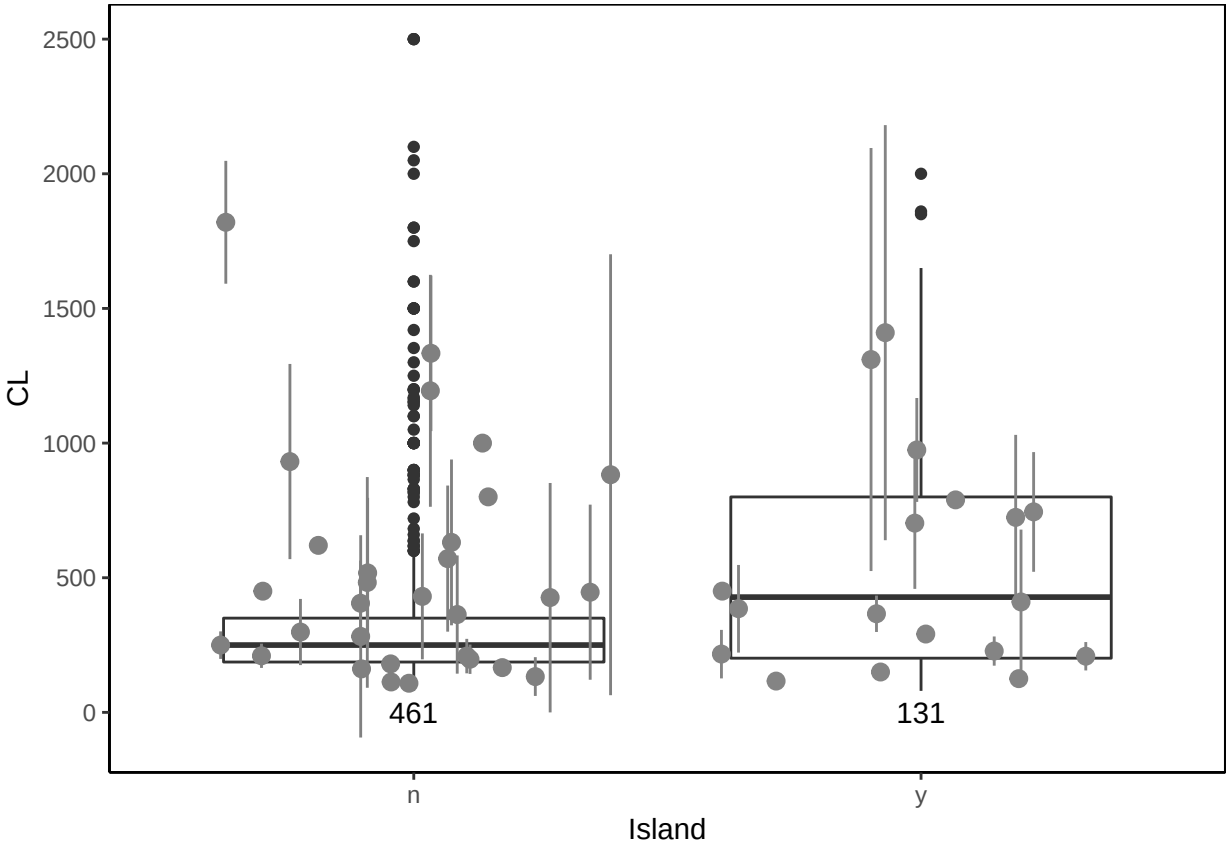
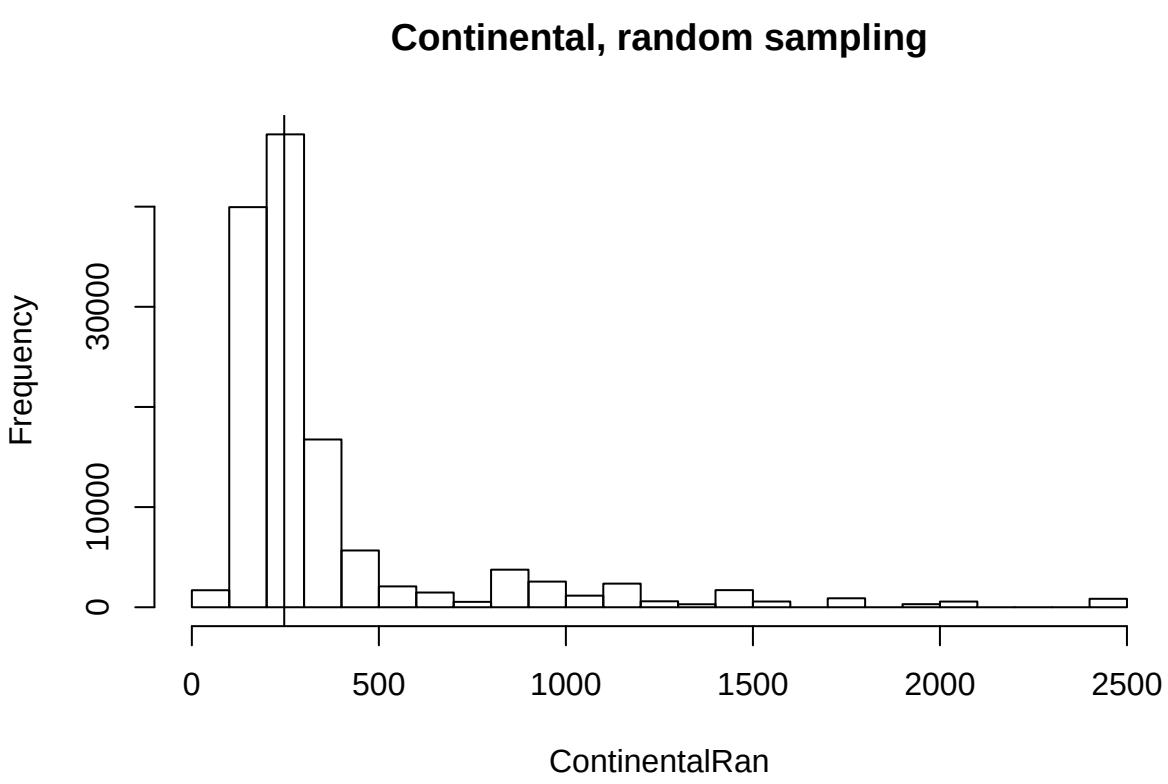


Figure 22: Boxplot continental vs. insular, genera summarised

```
## [1] 131
```

```
## [1] 131
```




```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  Insular and Continental
## W = 11354, p-value = 3.079e-06
## alternative hypothesis: true location shift is greater than 0
```

Wilcoxon Rank Sum Test (unpaired data):

continental $<$ insular ($\mathrm{P} = 3.0792713 \times 10^{-6}$)

continental vs. insular per time bin

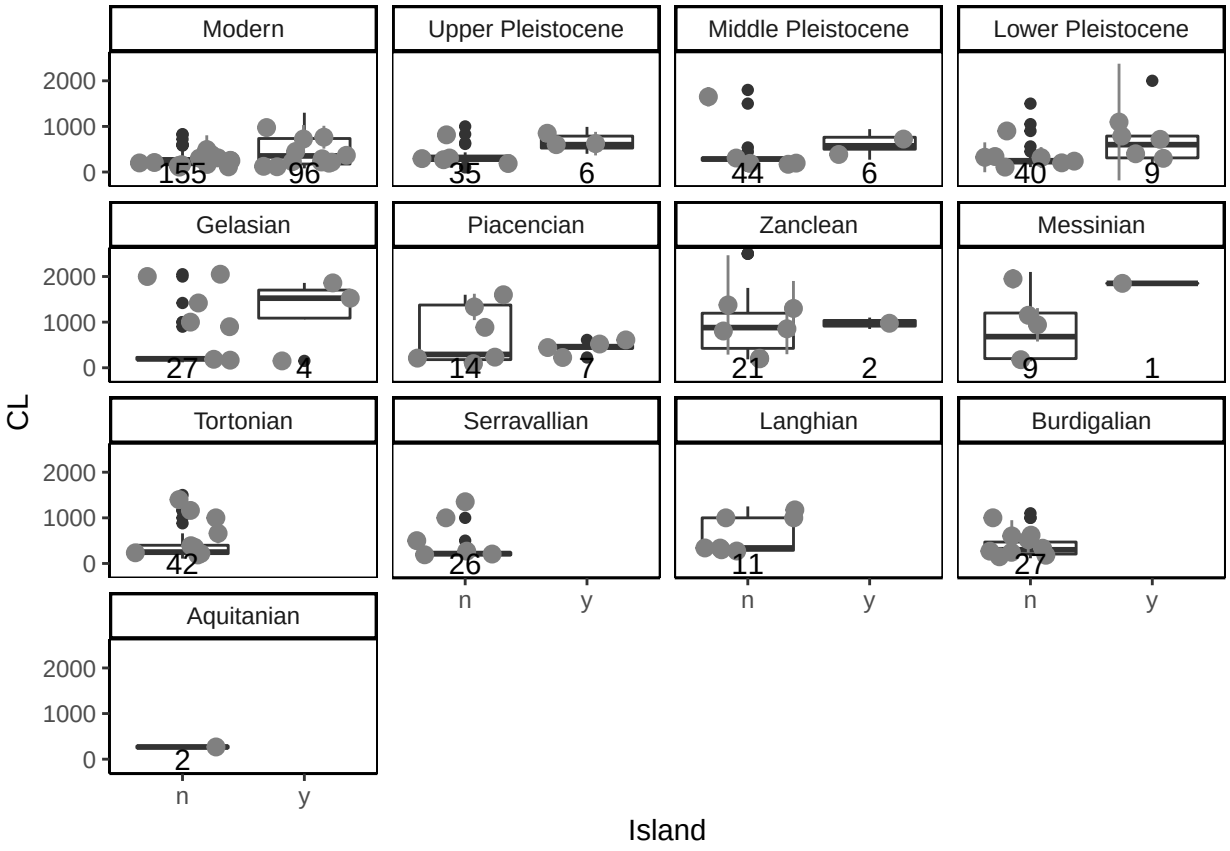


Figure 23: Boxplot continental vs. insular, genera summarised

continents

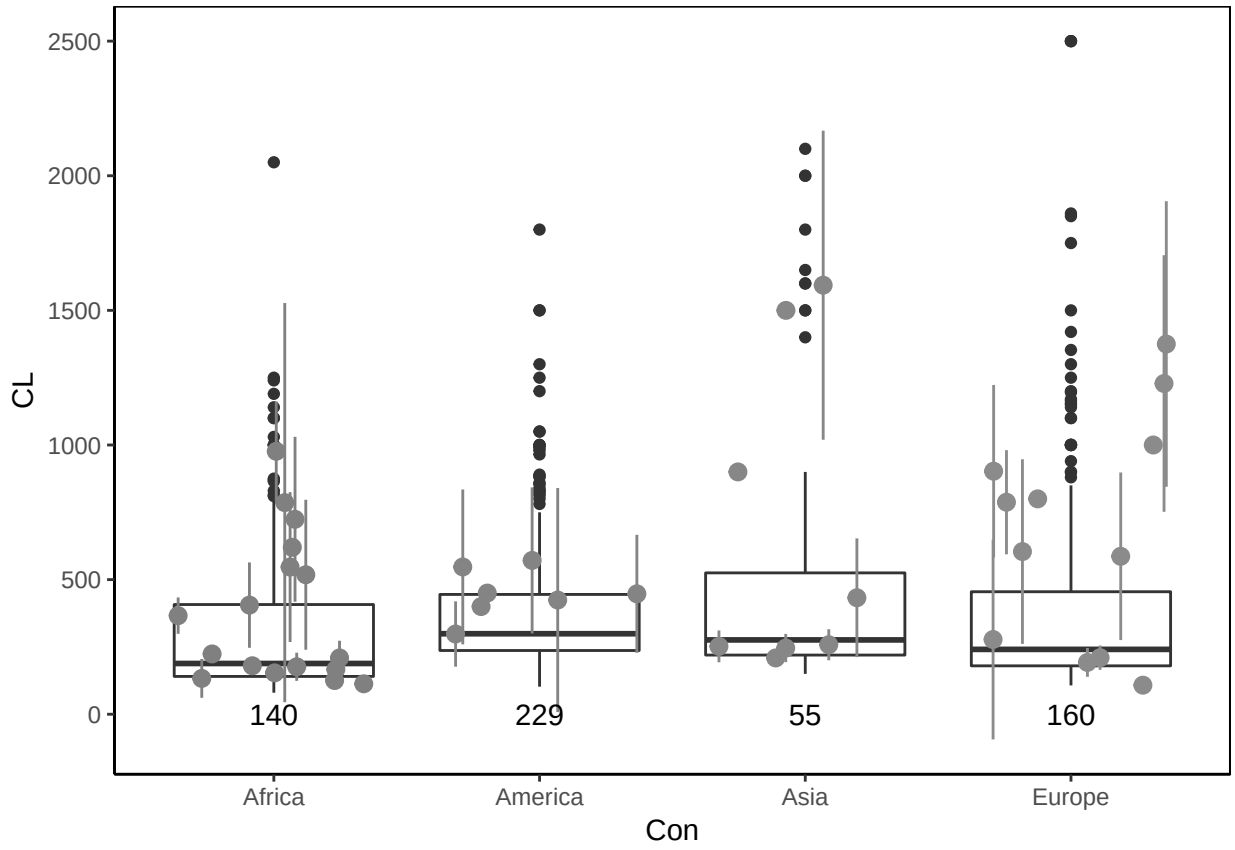
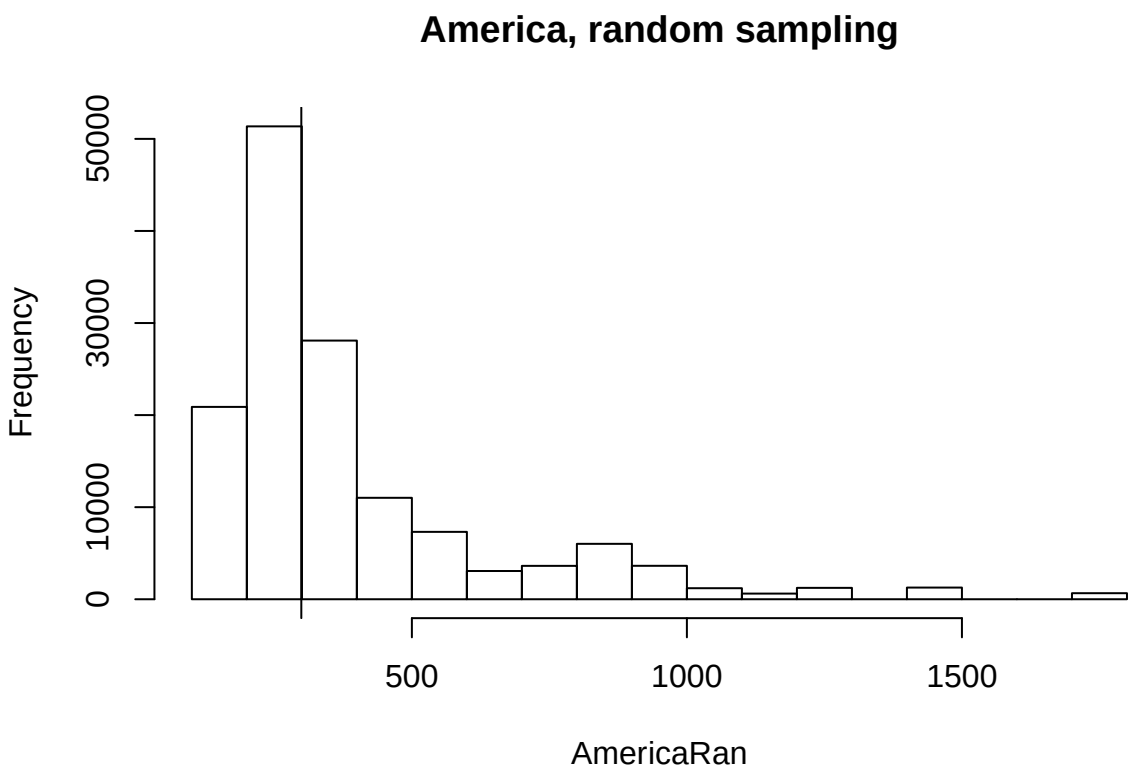
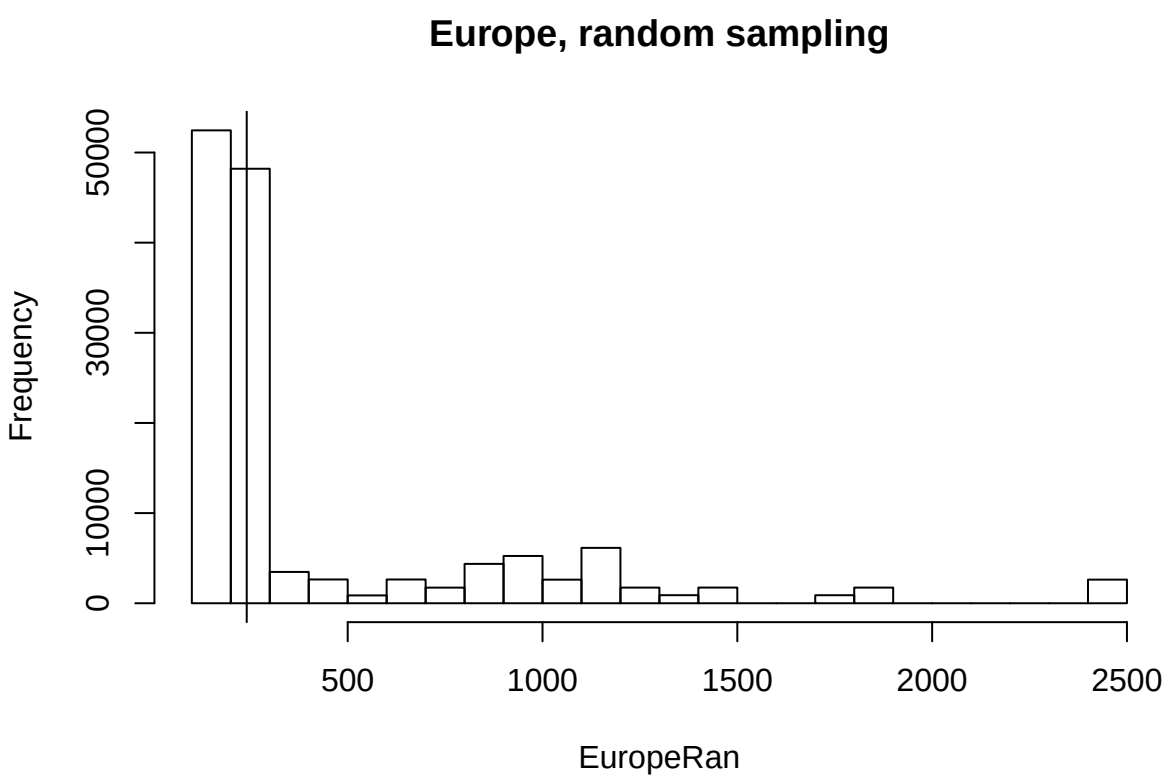
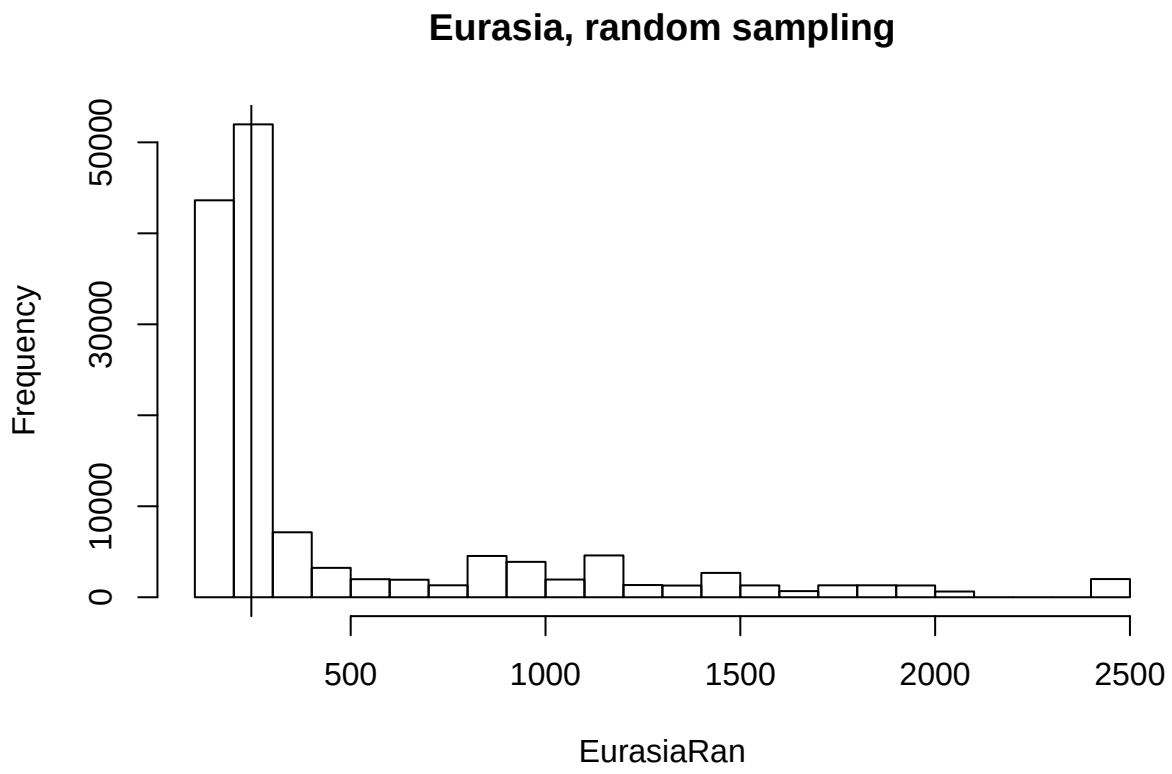


Figure 24: Boxplot: body size on different continents, genera summarised

```
## [1] 140

## [1] 340.4129

## [1] 140

## [1] 380.3443

## [1] 55

## [1] 160

## [1] 140

## [1] 481.9543
```


America, random sampling
Frequency
0
10000
30000
50000
500
1000
1500
AmericaRan


Europe, random sampling
Frequency
0
10000
30000
50000
500
1000
1500
2000
2500
EuropeRan




```
##
##  Kruskal-Wallis rank sum test
##
## data:  list(Africa, America, Eurasia, Europe)
## Kruskal-Wallis chi-squared = 29.514, df = 3, p-value = 1.746e-06
```

Kruskal-Wallis-Test:

Continent means differ ($P = 1.7462702 \times 10^{-6}$) (still have to look into the details...)

continents, continental vs. insular

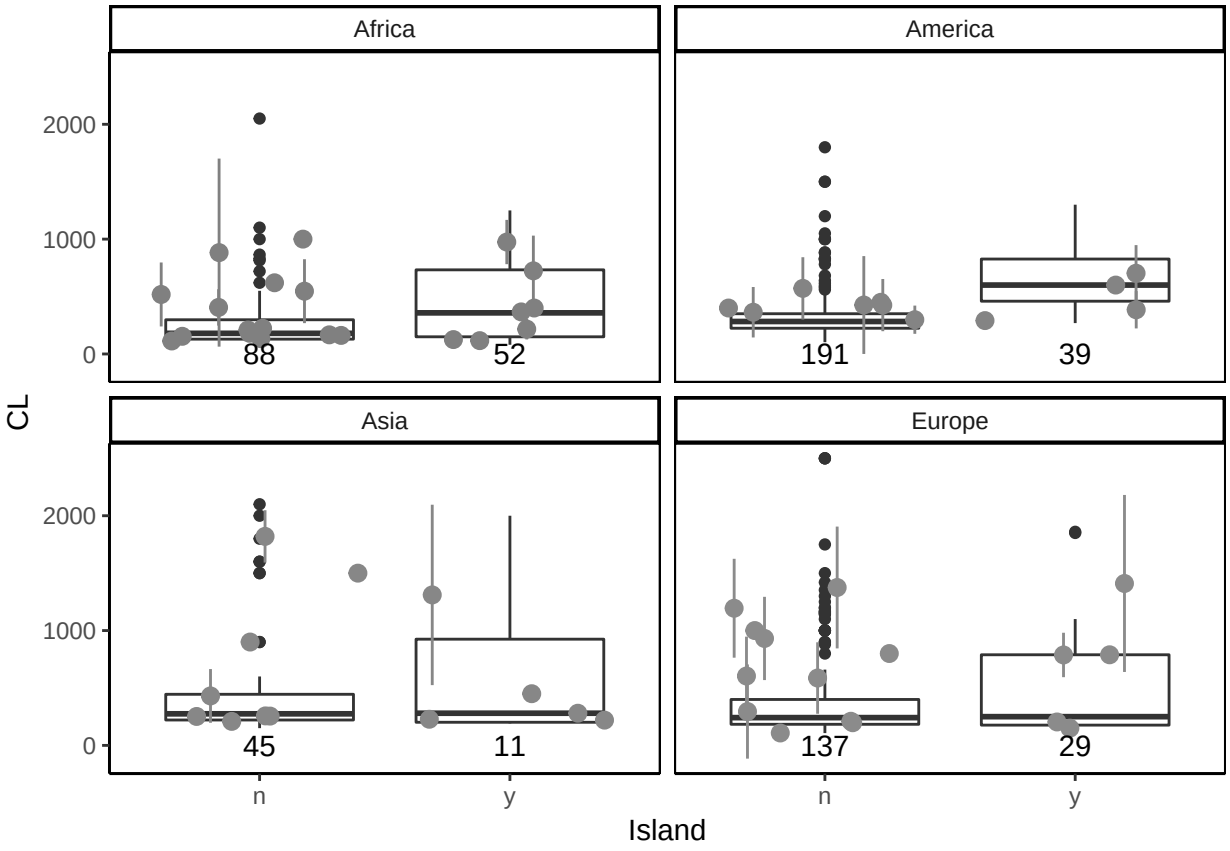


Figure 25: Boxplot: body size on different continents, genera summarised

paleoTS analysis

all (continental and insular)

genera (all)

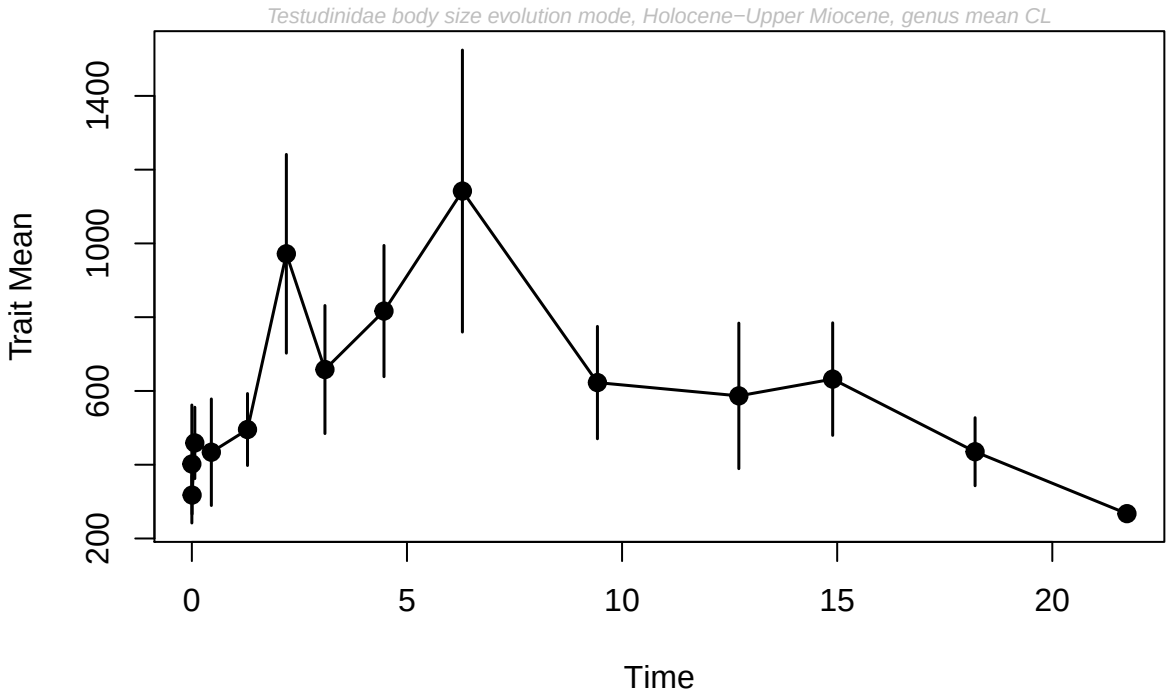


Figure 26: paleoTS plot with genus mean, including island species

Table 3: Model-fitting results for testudinidae, genera, including island species

	logL	K	AICc	Akaike.wt
GRW	-86.54583	2	178.2917	0.456
URW	-88.09463	1	178.5529	0.401
Stasis	-87.70575	2	180.6115	0.143

continental (excluding insular species)

genera (continental)

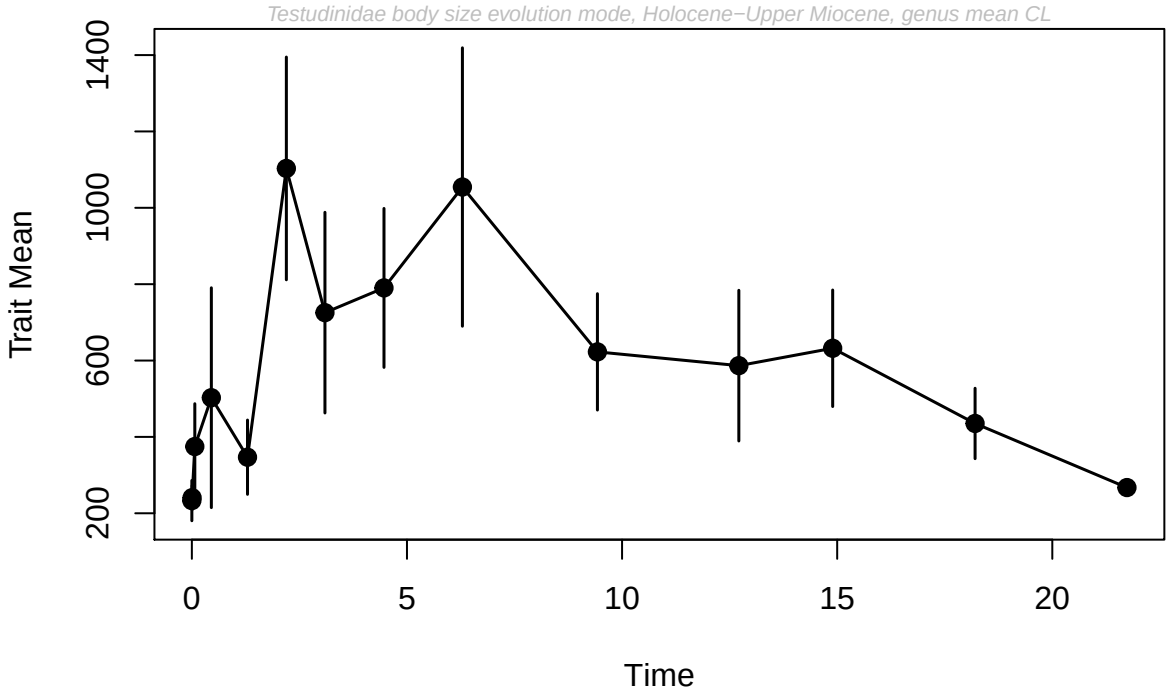


Figure 27: paleoTS plot with genus mean, excluding island species

Table 4: Model-fitting results for testudinidae, genera, excluding insular species

	logL	K	AICc	Akaike.wt
GRW	-88.13908	2	181.4782	0.509
URW	-89.81330	1	181.9902	0.394
Stasis	-89.79524	2	184.7905	0.097

insular (excluding continental)

genera (insular)

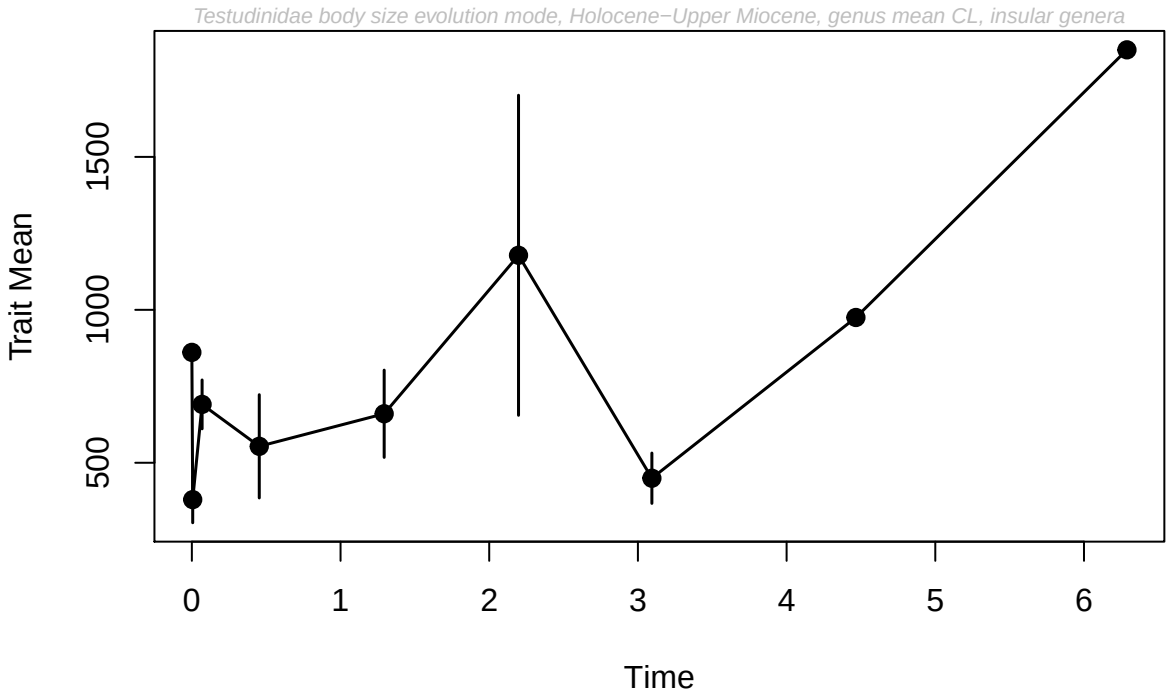


Figure 28: paleoTS plot with genus mean, only insular species

Table 5: Model-fitting results for testudinidae, genera, only insular species

	logL	K	AICc	Akaike.wt
GRW	-68.53661	2	143.4732	0
URW	-75.21017	1	153.0870	0
Stasis	-60.66617	2	127.7323	1

per continent

Europe, smaller original bins (see Table 2), genera

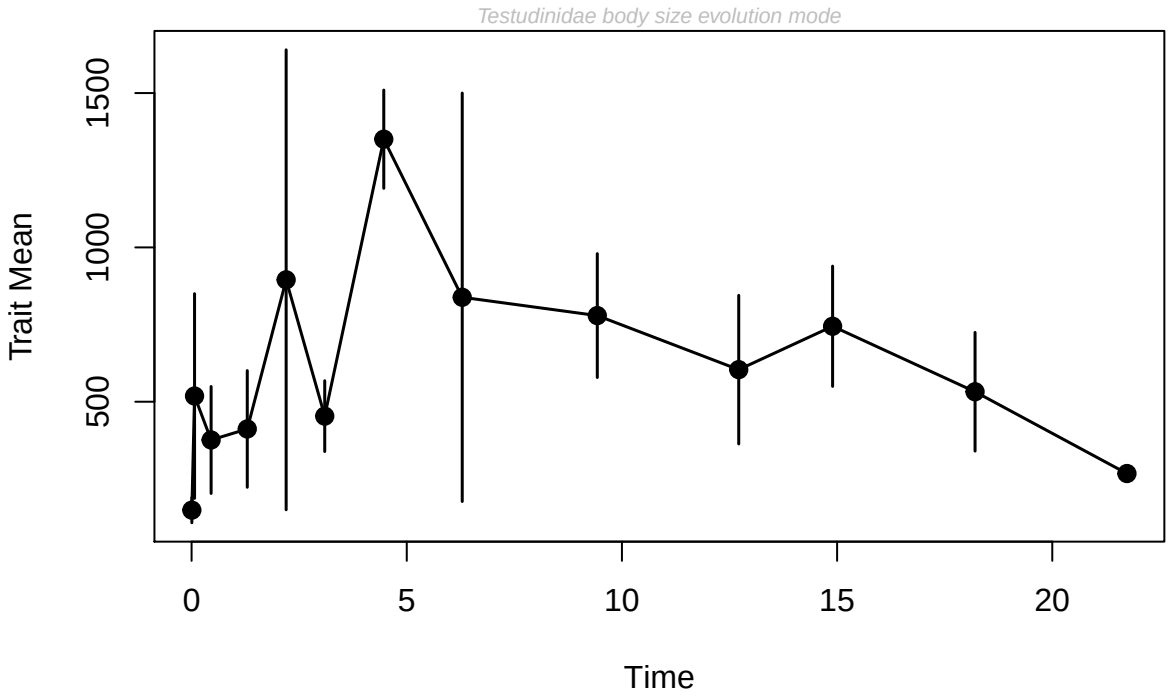


Figure 29: Smaller original bins, genera, Europe

Table 6: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-95.55732	2	196.4480	0.000
URW	-95.59591	1	193.5918	0.001
Stasis	-86.80402	2	178.9414	0.999

Europe, smaller original bins (see Table 2), genera, continental

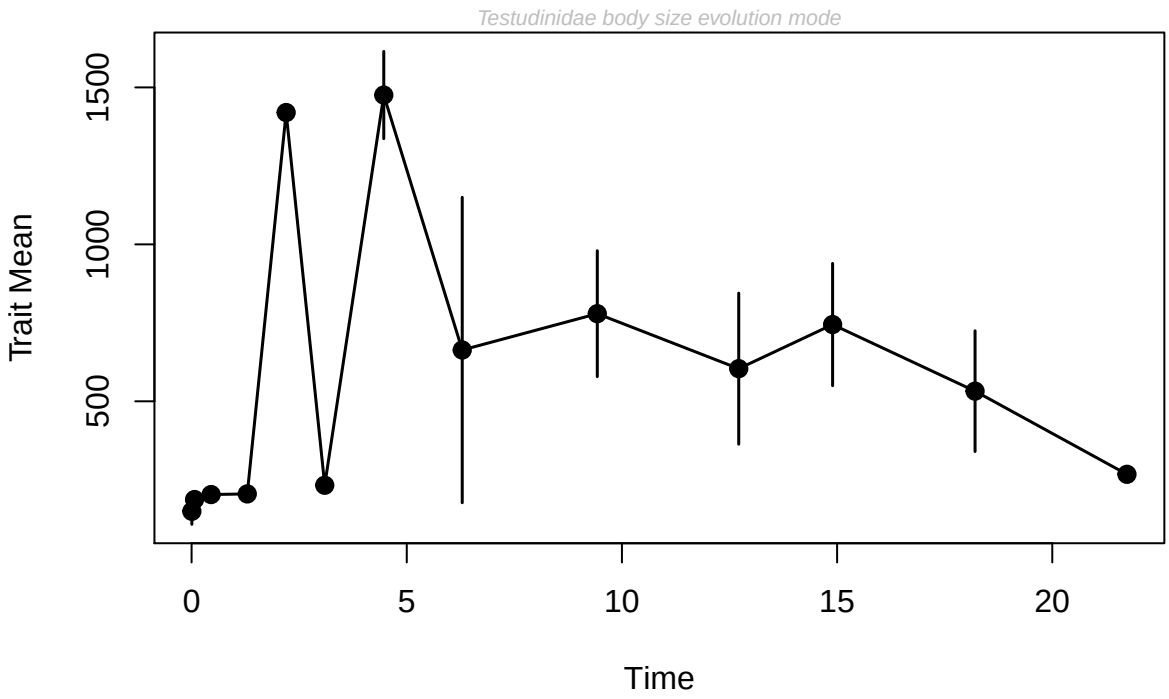


Figure 30: Smaller original bins, genera, Europe, continental

Table 7: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-95.83419	2	197.0017	0.005
URW	-100.70965	1	203.8193	0.000
Stasis	-90.46821	2	186.2697	0.995

Europe, smaller original bins (see Table 2), genera, insular

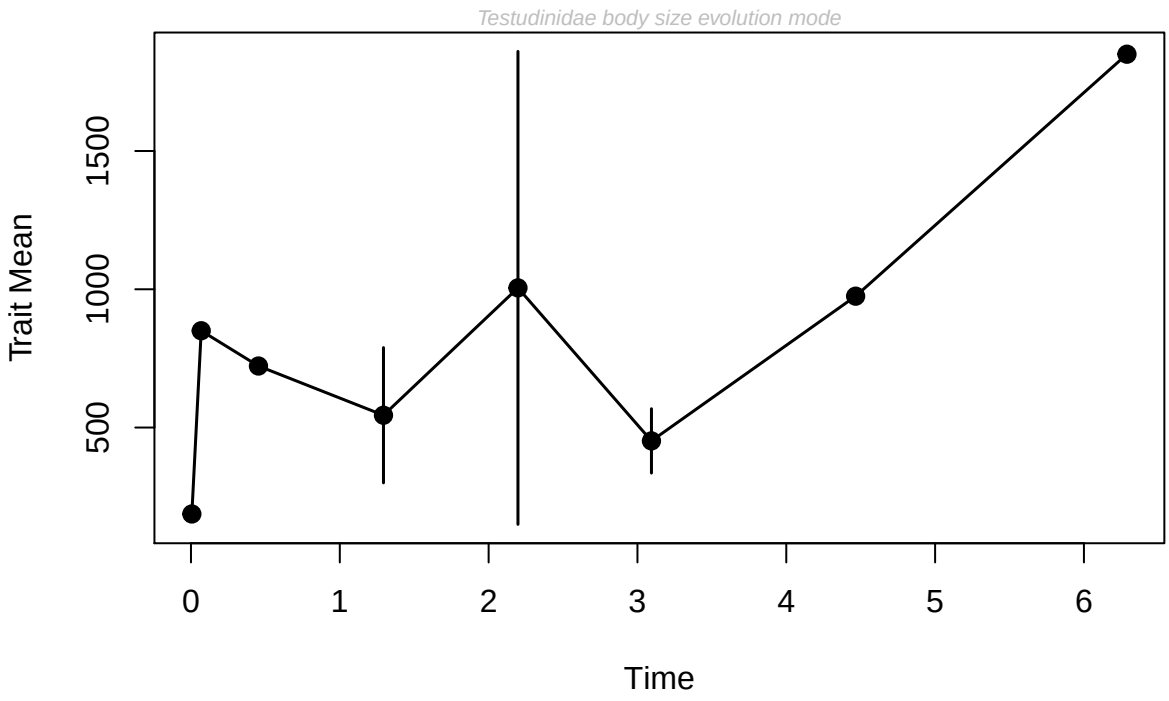


Figure 31: Smaller original bins, genera, Europe, insular

Table 8: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-83.41151	2	173.8230	0
URW	-106.95280	1	216.7056	0
Stasis	-58.79471	2	124.5894	1

Eurasia, smaller original bins (See Table 2), genera

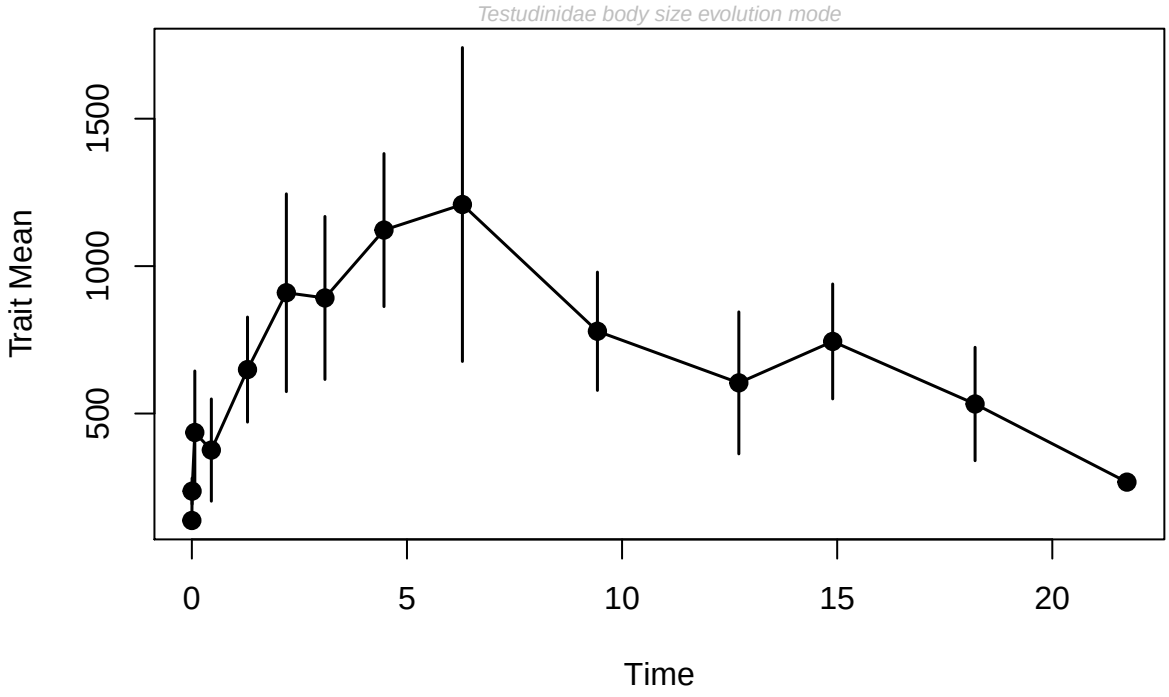


Figure 32: Smaller original bins, genera, Eurasia

Table 9: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-90.30184	2	185.8037	0.327
URW	-91.07443	1	184.5125	0.624
Stasis	-92.20157	2	189.6031	0.049

Eurasia, smaller original bins (See Table 2), genera, continental

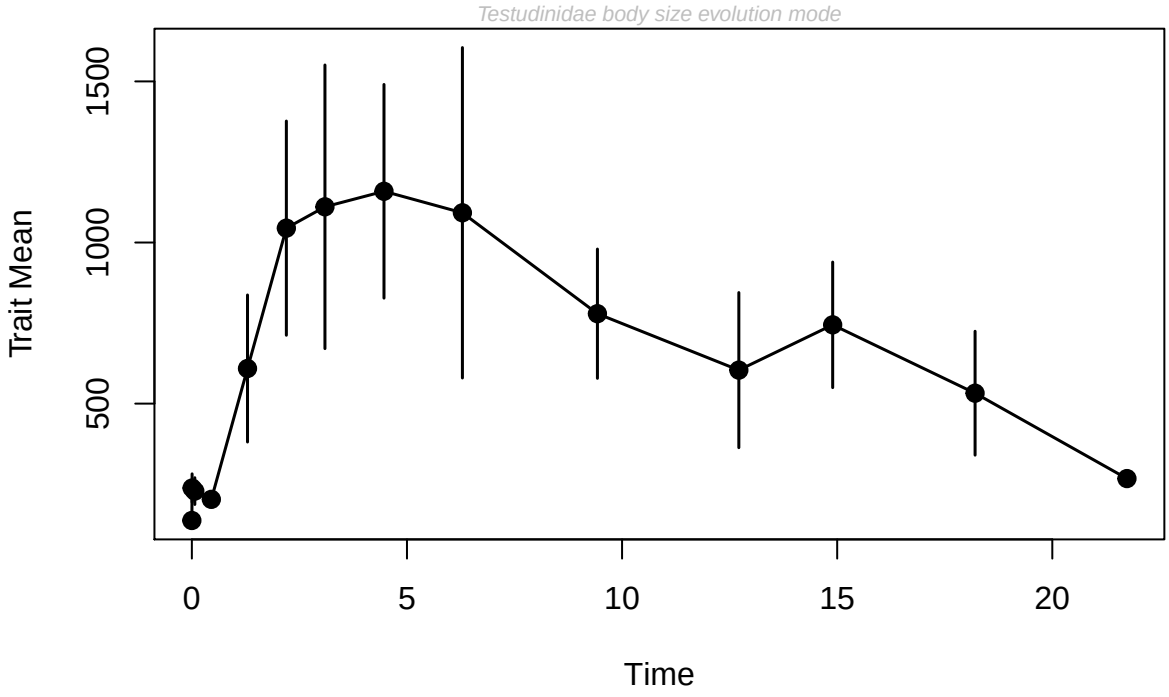


Figure 33: Smaller original bins, genera, Eurasia, continental

Table 10: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-88.52802	2	182.2560	0.363
URW	-89.38508	1	181.1338	0.636
Stasis	-94.04099	2	193.2820	0.001

Eurasia, smaller original bins (See Table 2), genera, insular

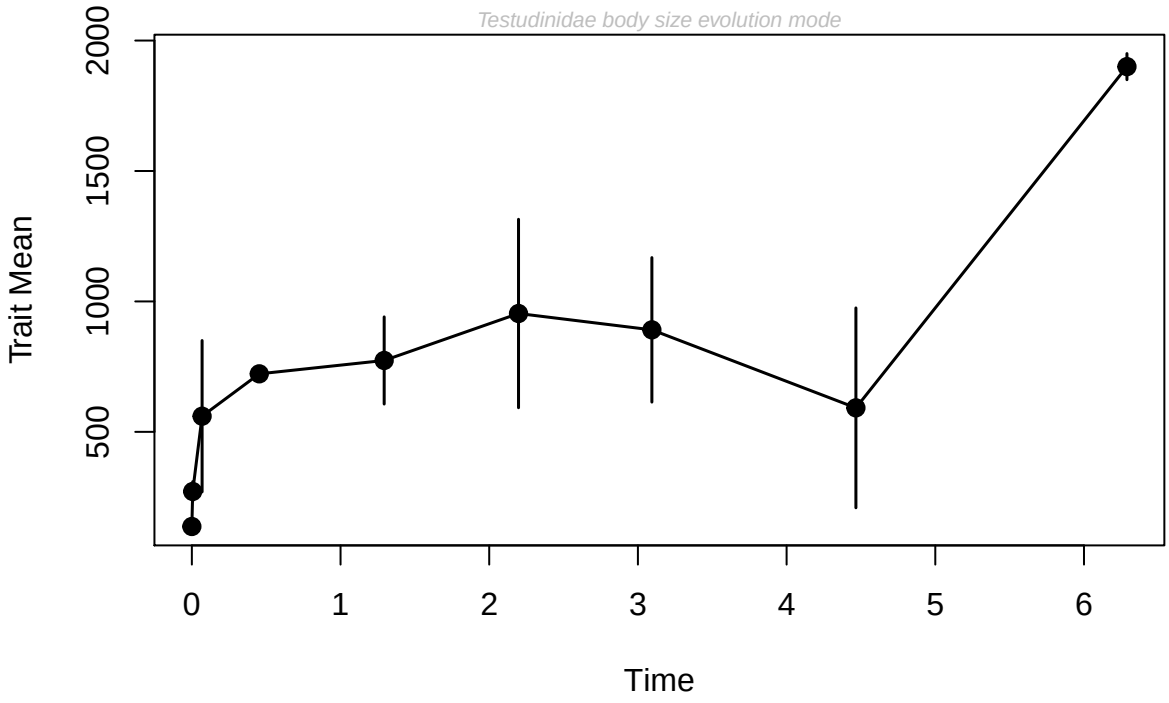


Figure 34: Smaller original bins, genera, Eurasia, insular

Table 11: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-62.34782	2	131.0956	0.178
URW	-64.75816	1	132.1830	0.103
Stasis	-60.95210	2	128.3042	0.719