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	254	66	18
(0.0117,0.126]	Upper Pleistocene	Upper Pleistocene	0.06885	50	18	8
(0.126,0.781]	Middle Pleistocene	Middle Pleistocene	0.45350	53	13	7
(0.781,1.81]	Lower Pleistocene	Lower Pleistocene	1.29350	57	27	12
(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	31	17	8
(5.33,7.25]	Messinian	Upper Miocene	6.28900	12	9	6
(7.25,11.6]	Tortonian	Upper Miocene	9.42700	46	20	9
(11.6,13.8]	Serravallian	Middle Miocene	12.71400	27	8	6
(13.8,16]	Langhian	Middle Miocene	14.89500	18	14	9
(16,20.4]	Burdigalian	Lower Miocene	18.20500	29	15	9
(20.4,23]	Aquitanian	Lower Miocene	21.73500	2	1	1

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

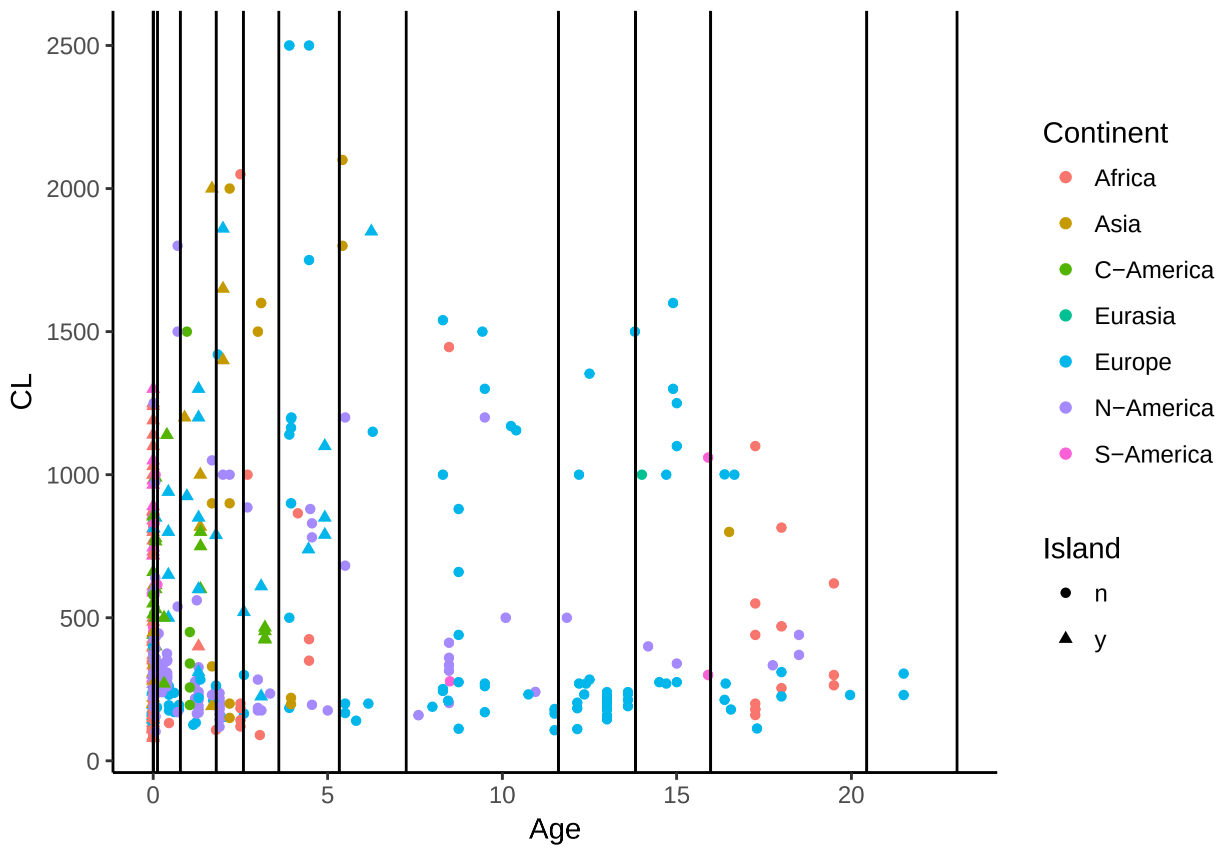


Figure 1: Scatterplot of CL over time, indicating insular (triangle) and continental (circles) and colour indicating continents. Lines indicte bins, dashed line = new bins.

Maps

fossil occurences of testudinidae

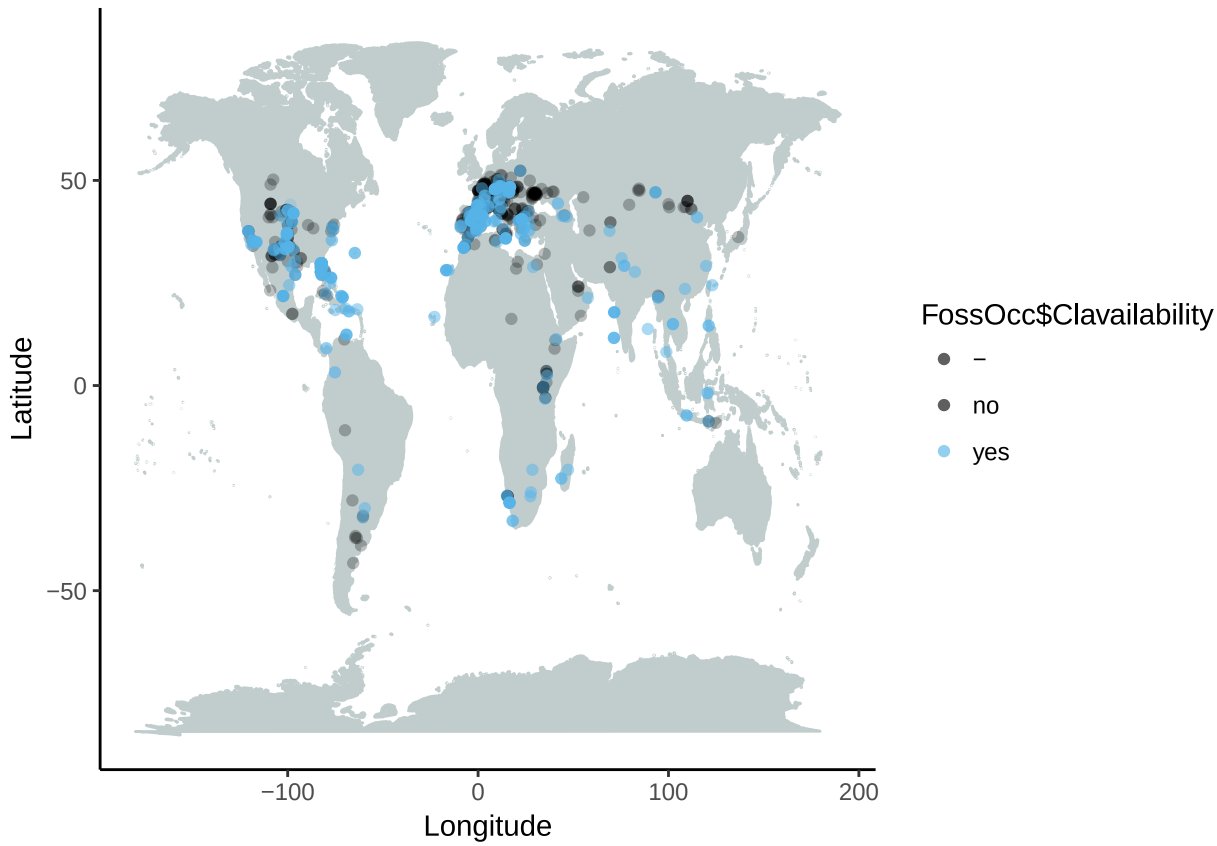


Figure 2: Map displaying all fossil occurrences of testudinids, with color indicating whether relevant literature was available (black if not) and if it was, whether body size data was available or not (yes and no, respectively).

body size of testudinidae

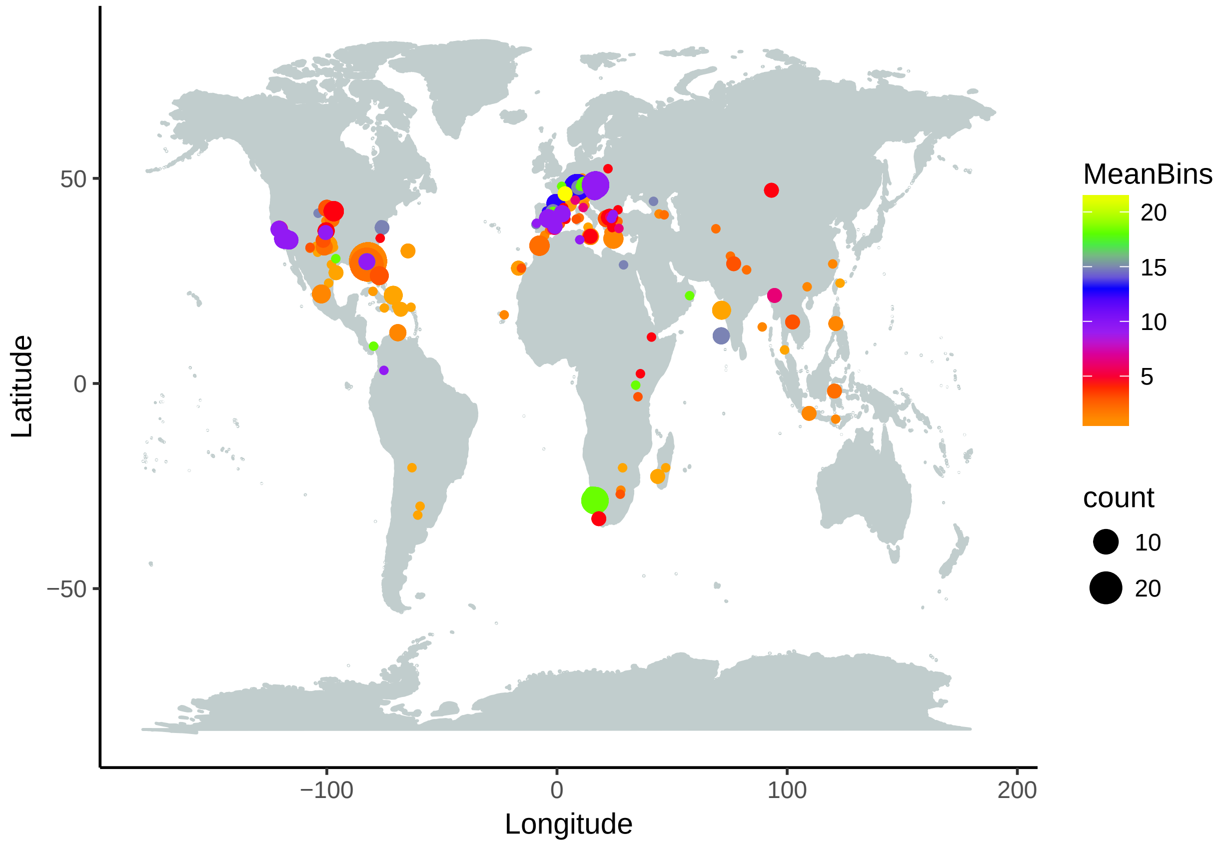
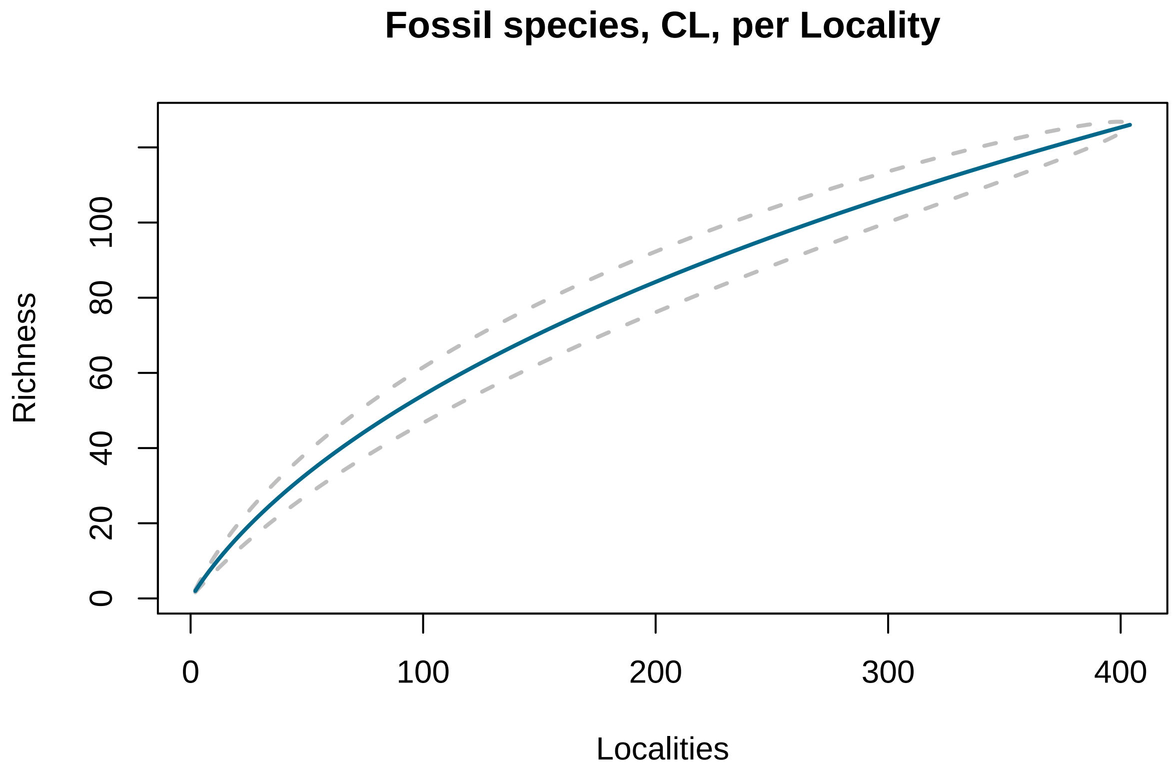
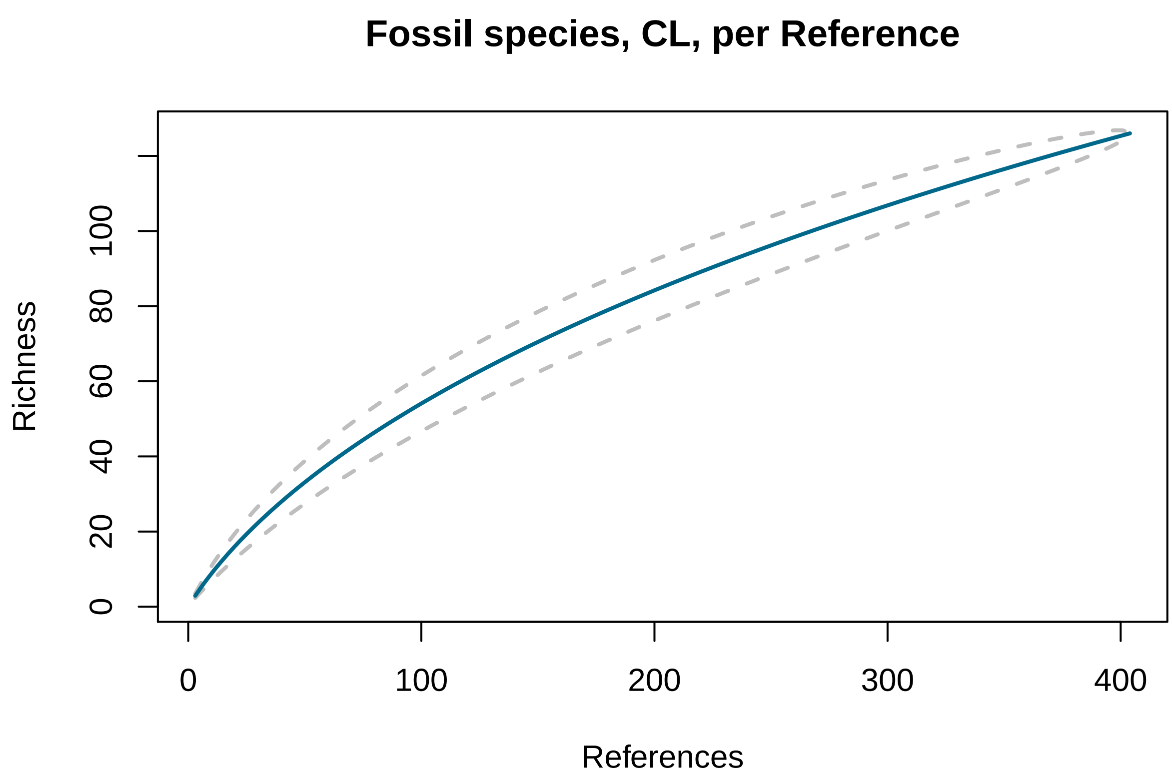


Figure 3: Map displaying all localities for which body size data for testudinids was available in the literature. Size of points denotes sample size, color denotes approximate age.

Sampling Accumulation Curves





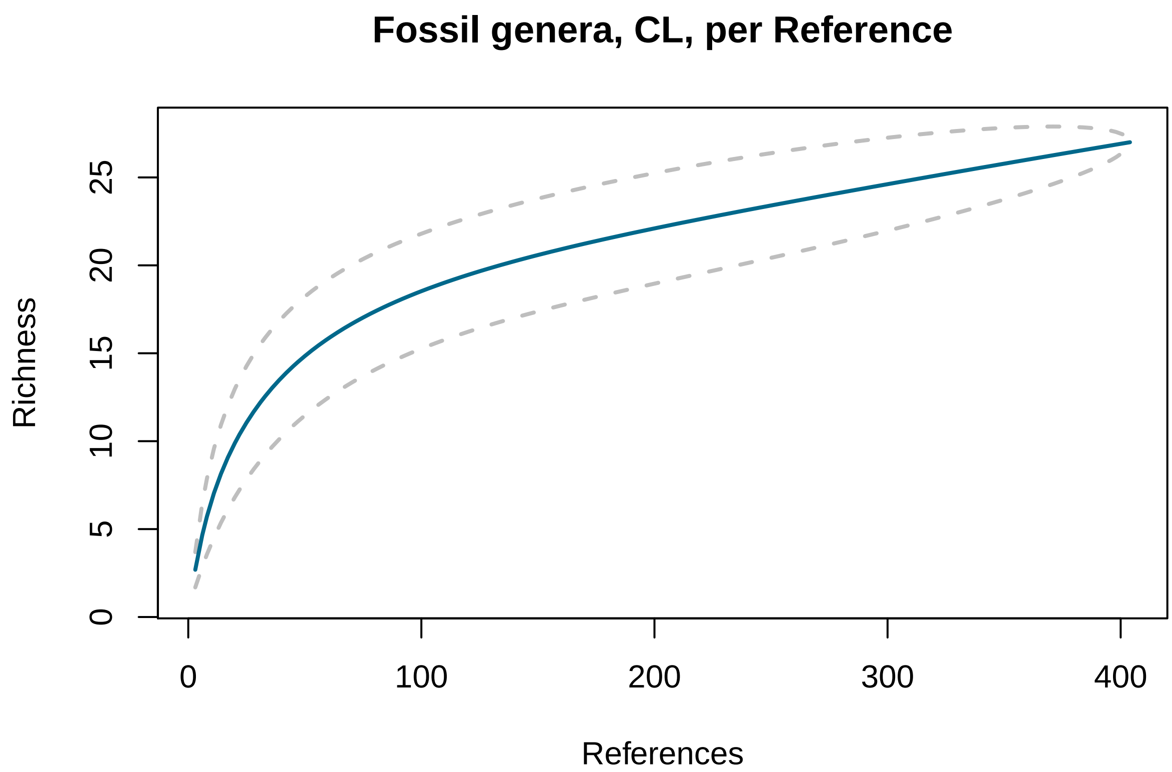


Figure 4: Sampling Accumulation Curve of fossil genera per reference

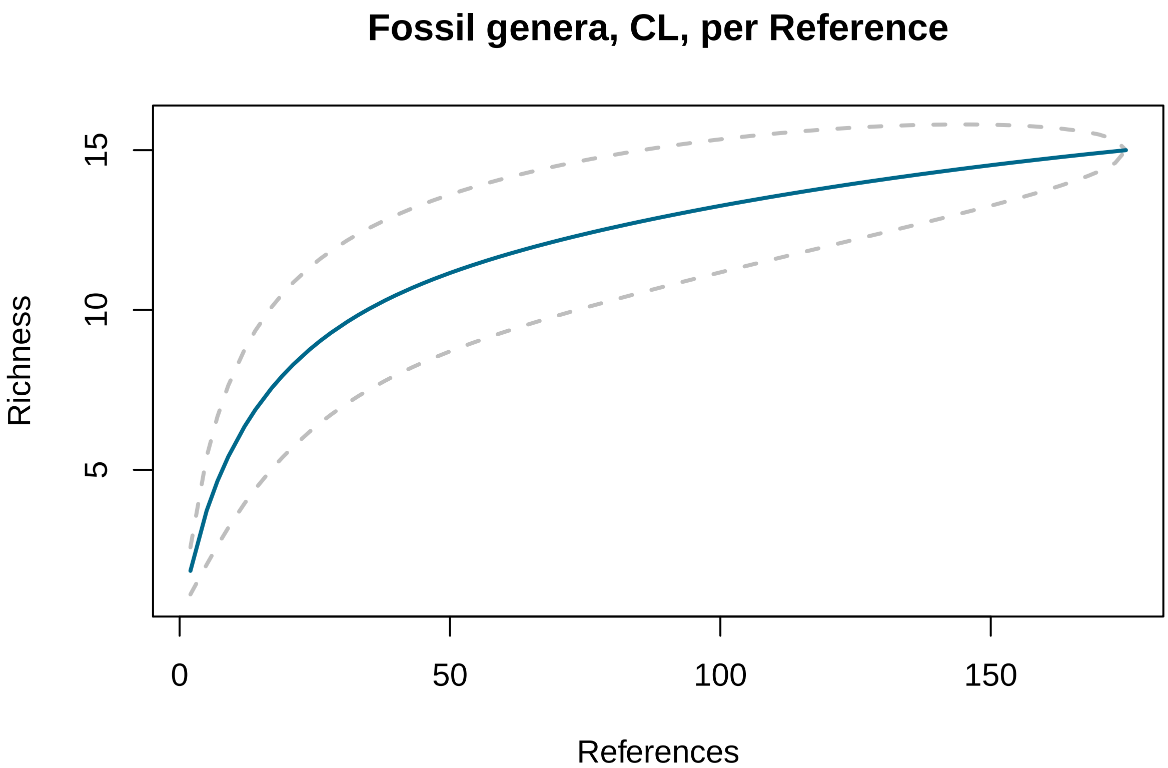


Figure 5: Sampling Accumulation Curve of fossil genera per reference, Eurasia

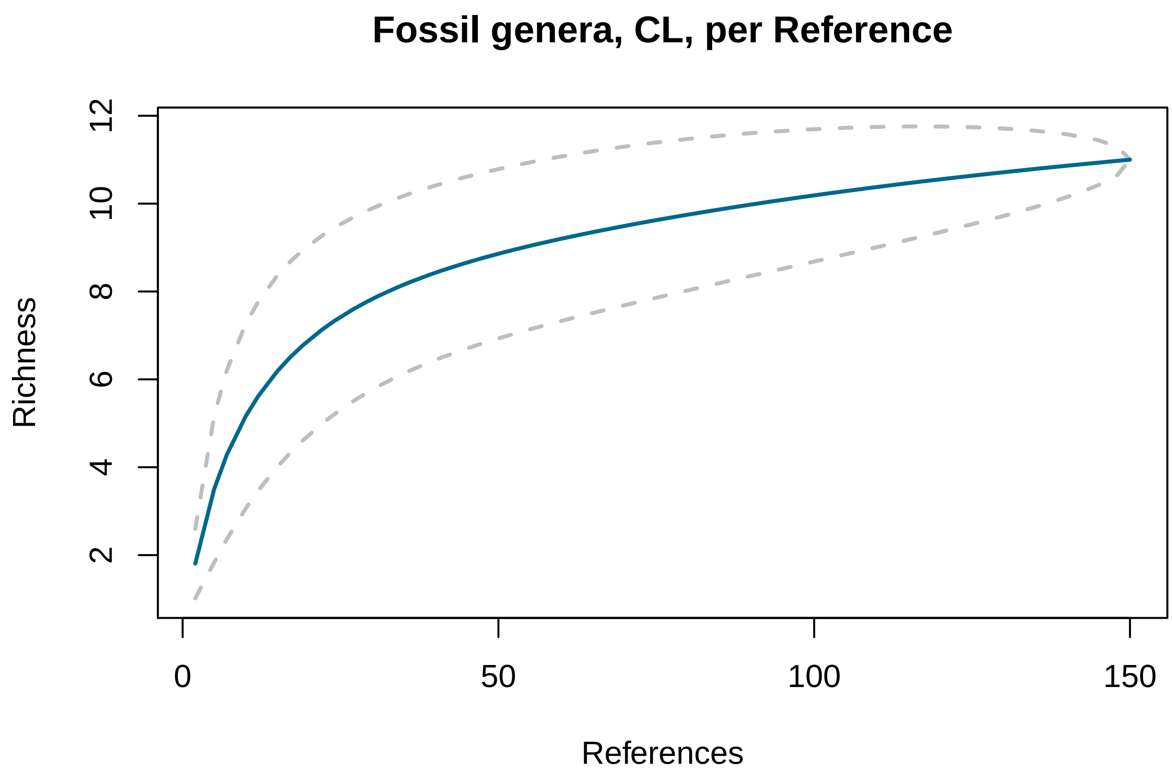


Figure 6: Sampling Accumulation Curve of fossil genera per reference, Europe

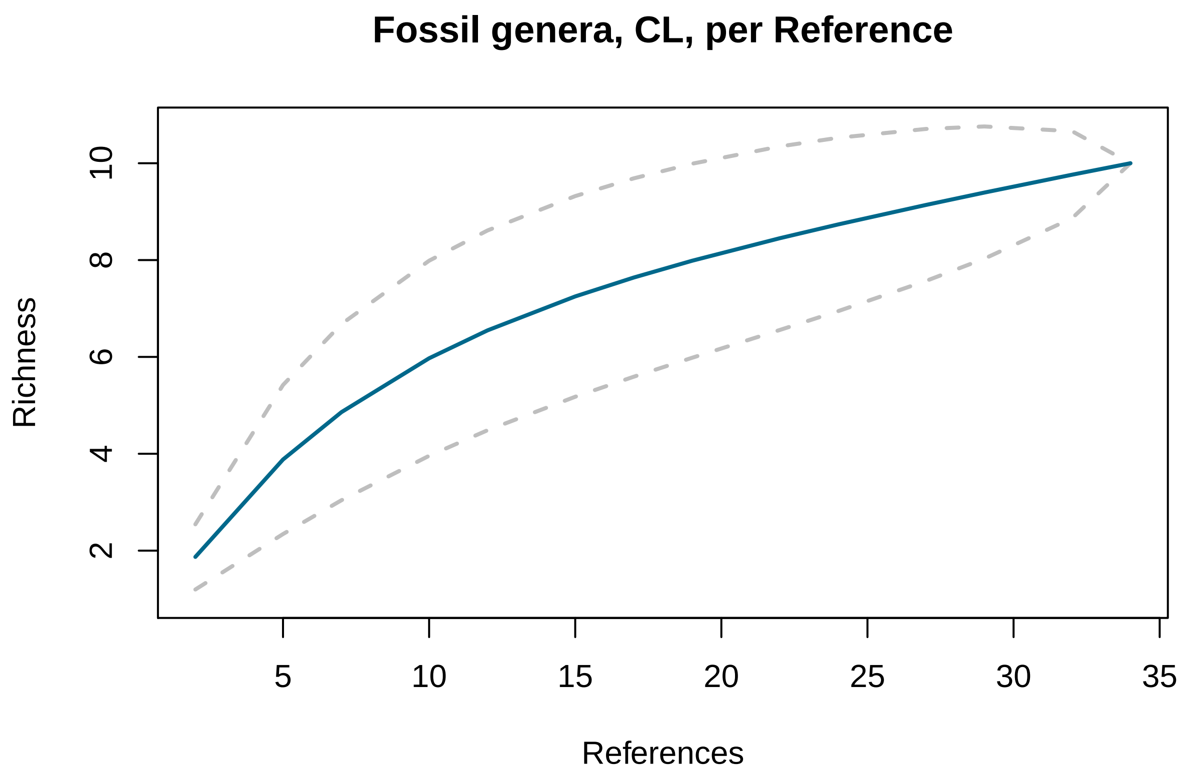


Figure 7: Sampling Accumulation Curve of fossil genera per reference, Africa

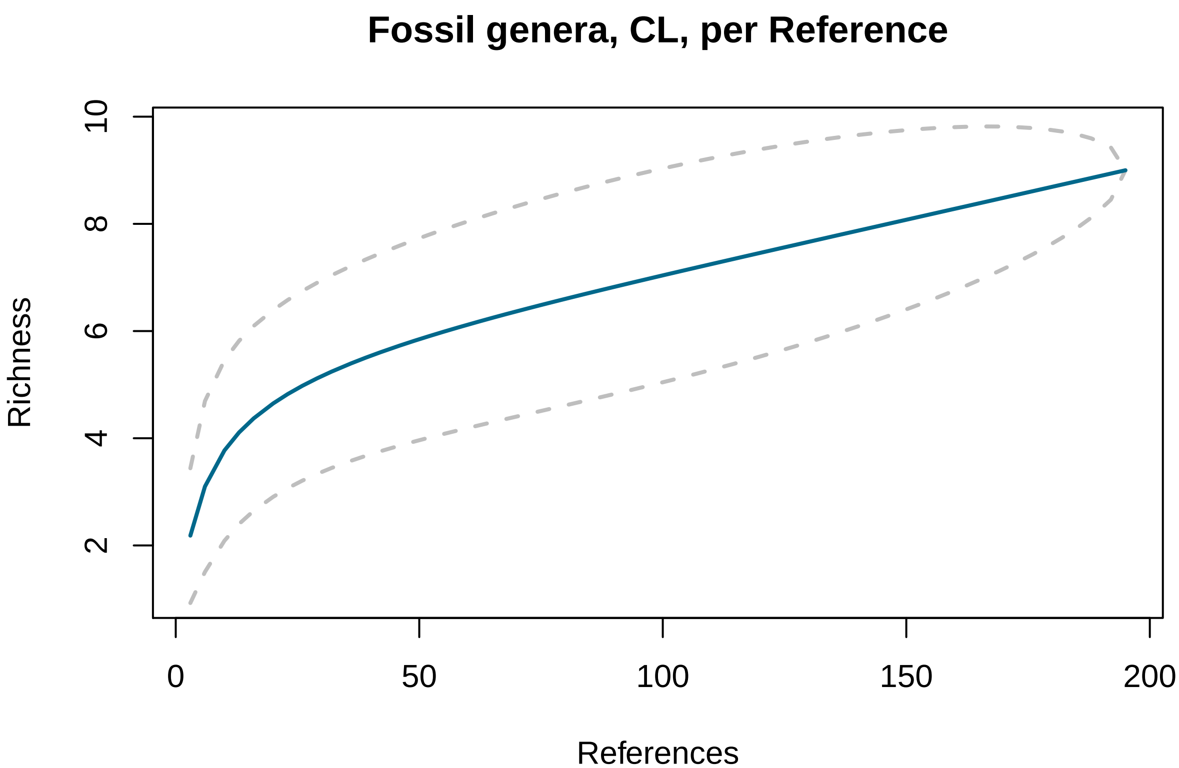


Figure 8: Sampling Accumulation Curve of fossil genera per reference, America

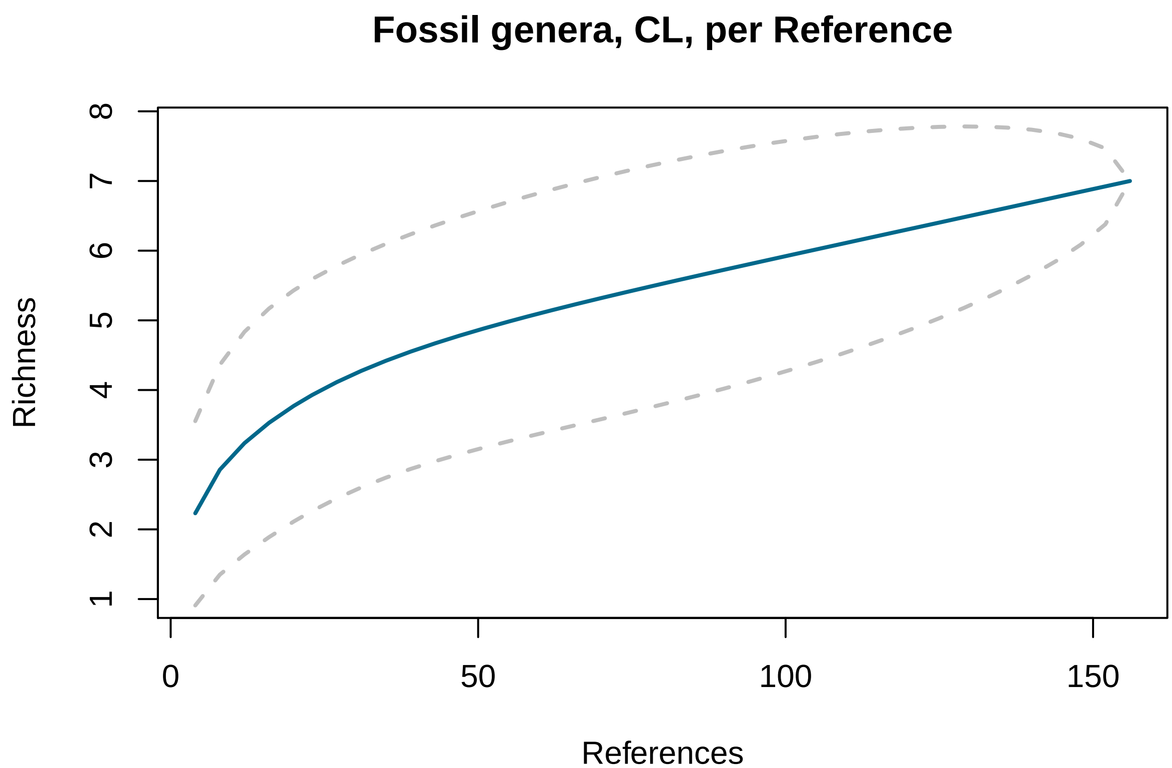


Figure 9: Sampling Accumulation Curve of fossil genera per reference, N-America

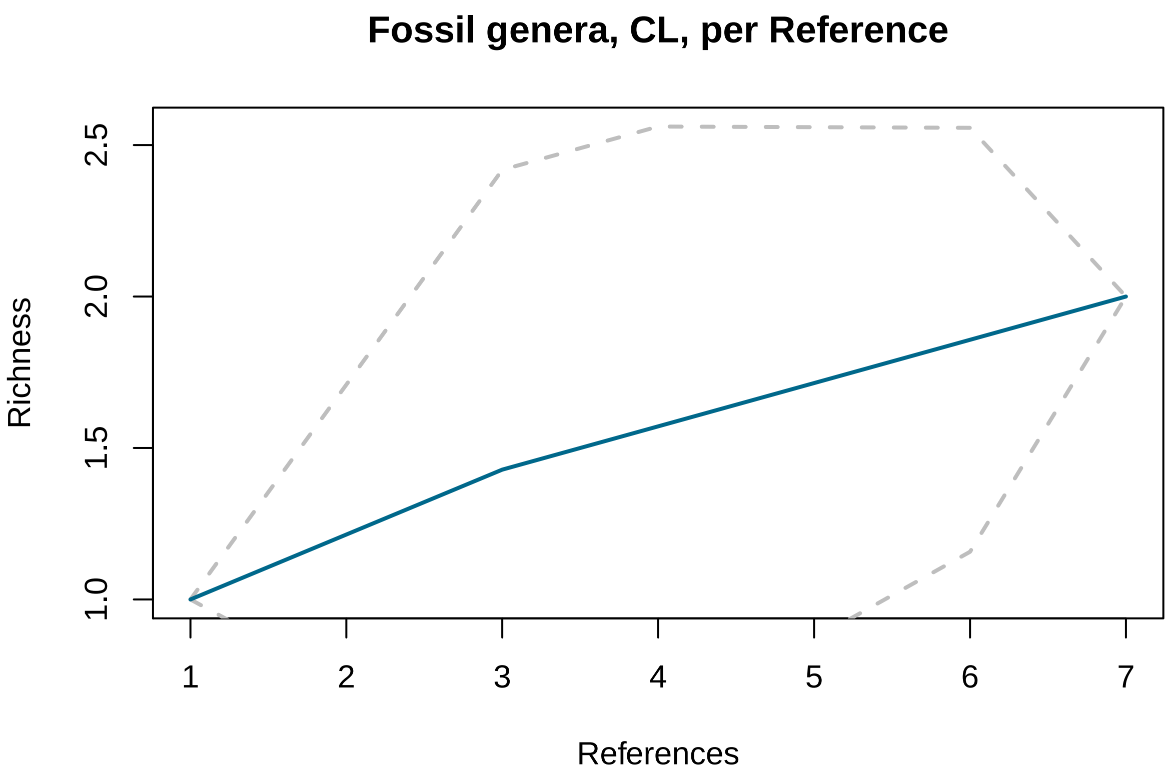


Figure 10: Sampling Accumulation Curve of fossil genera per reference, S-America

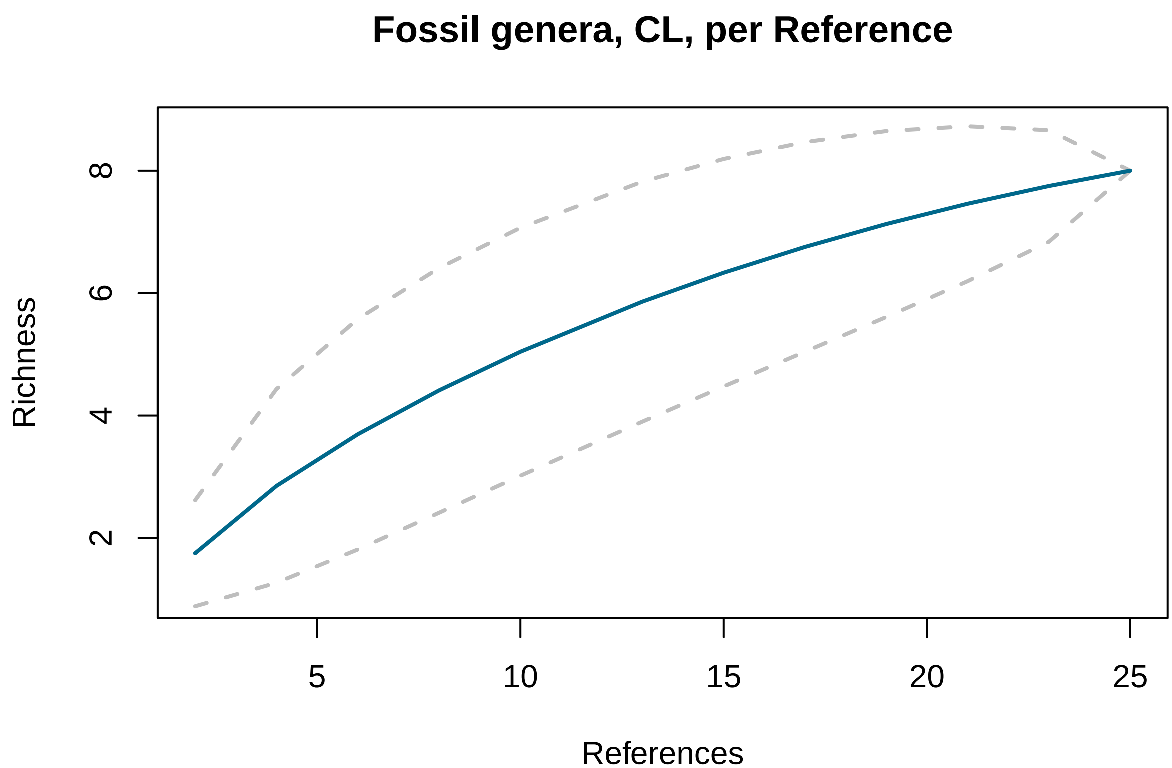


Figure 11: Sampling Accumulation Curve of fossil genera per reference, Asia

Histograms

all

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

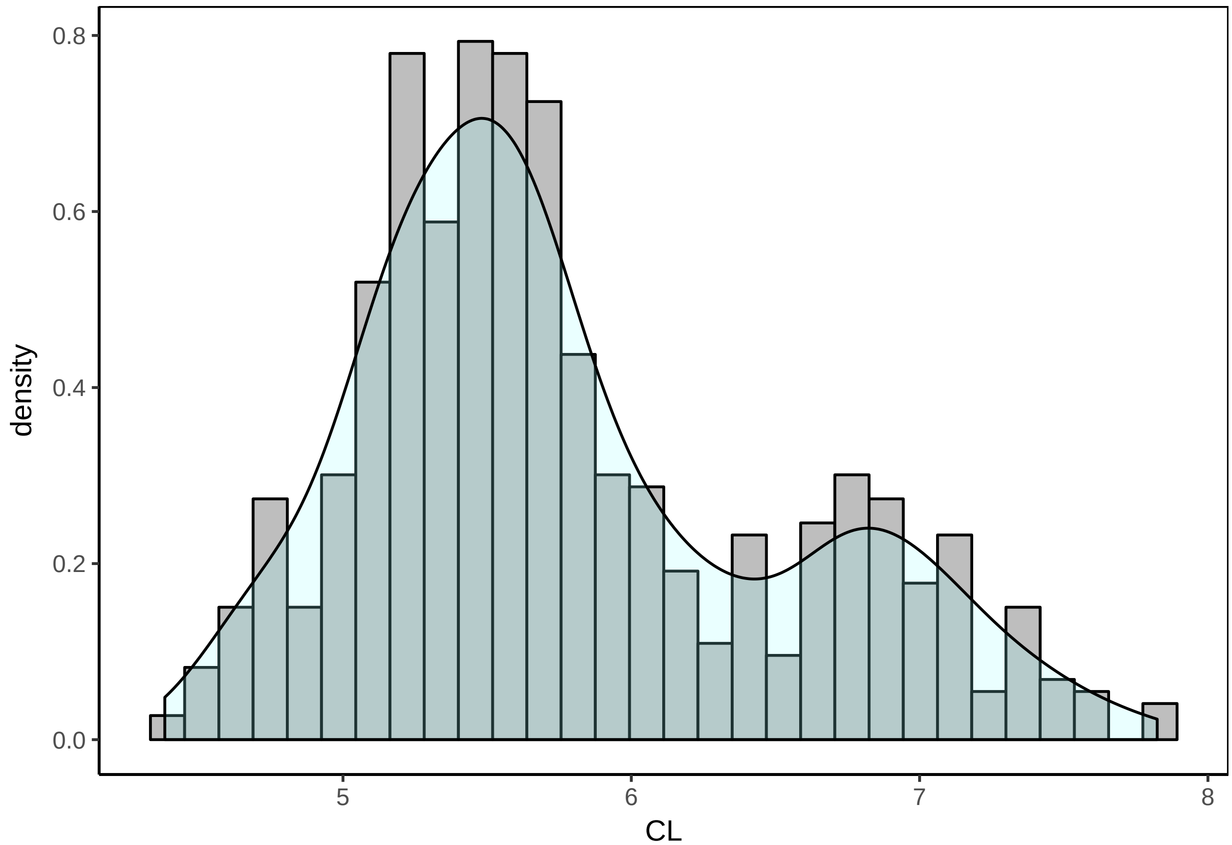
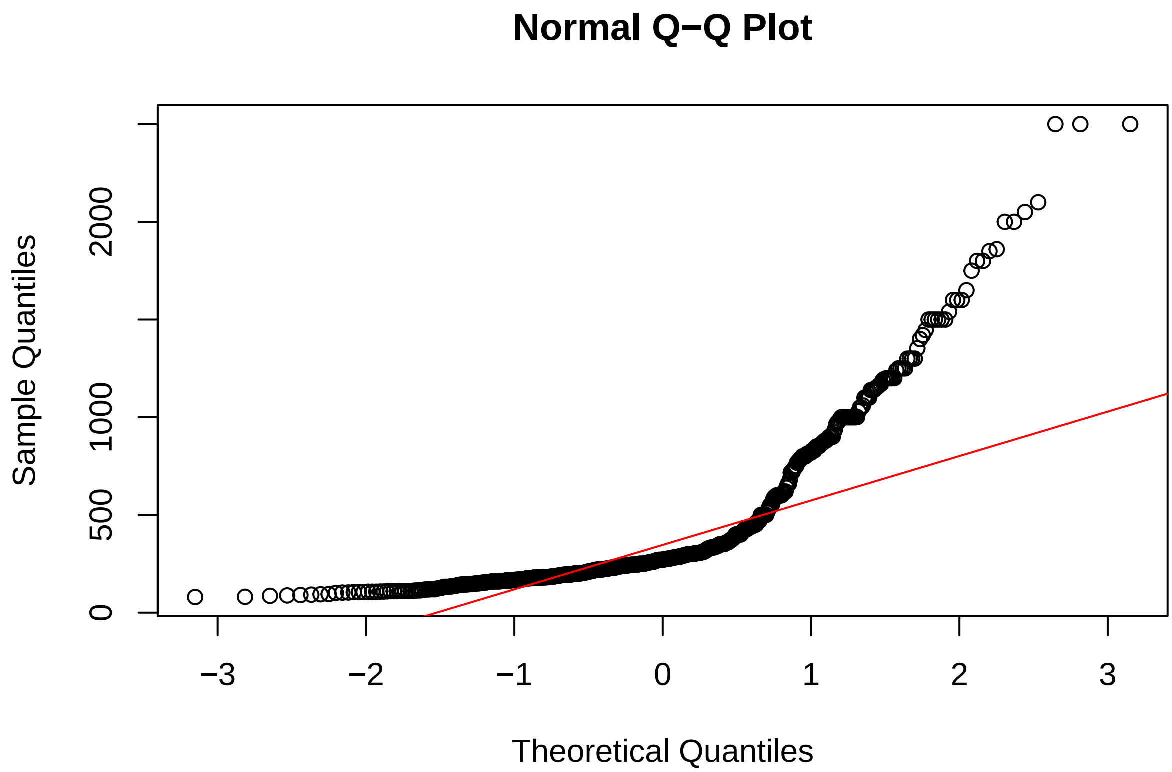
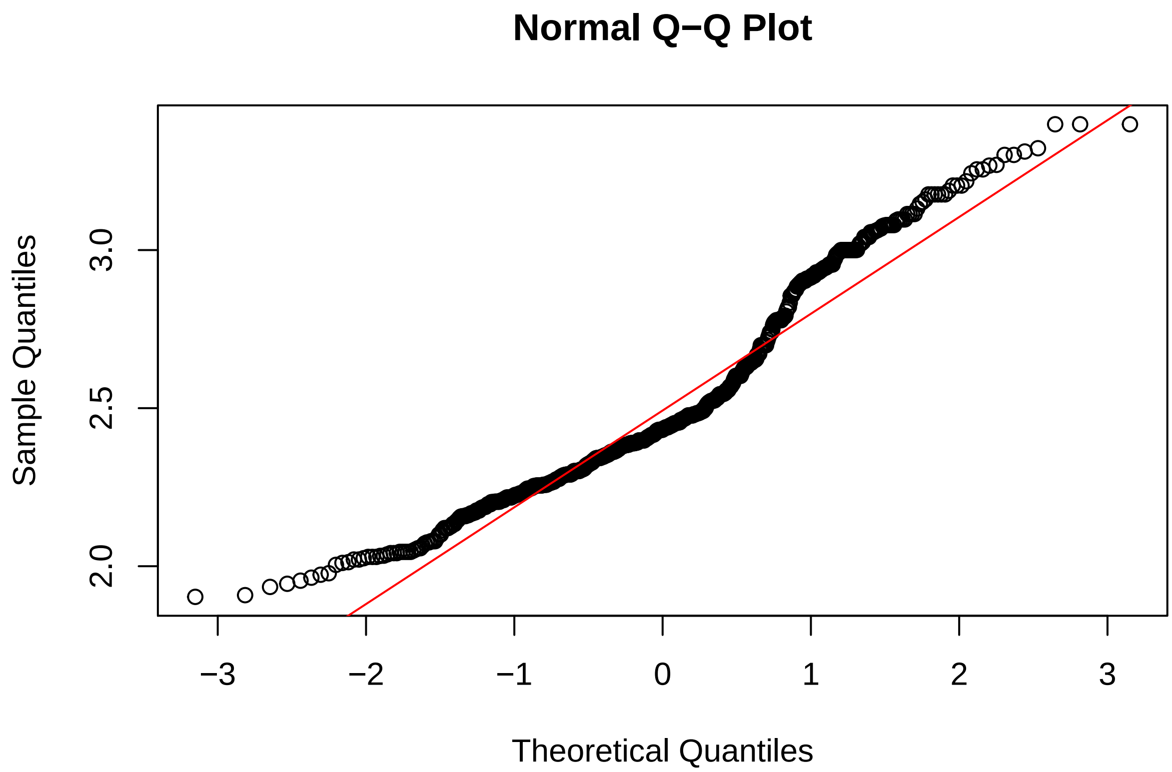


Figure 12: Distribution of body size data, logtransformed, all data.

```
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`.
```

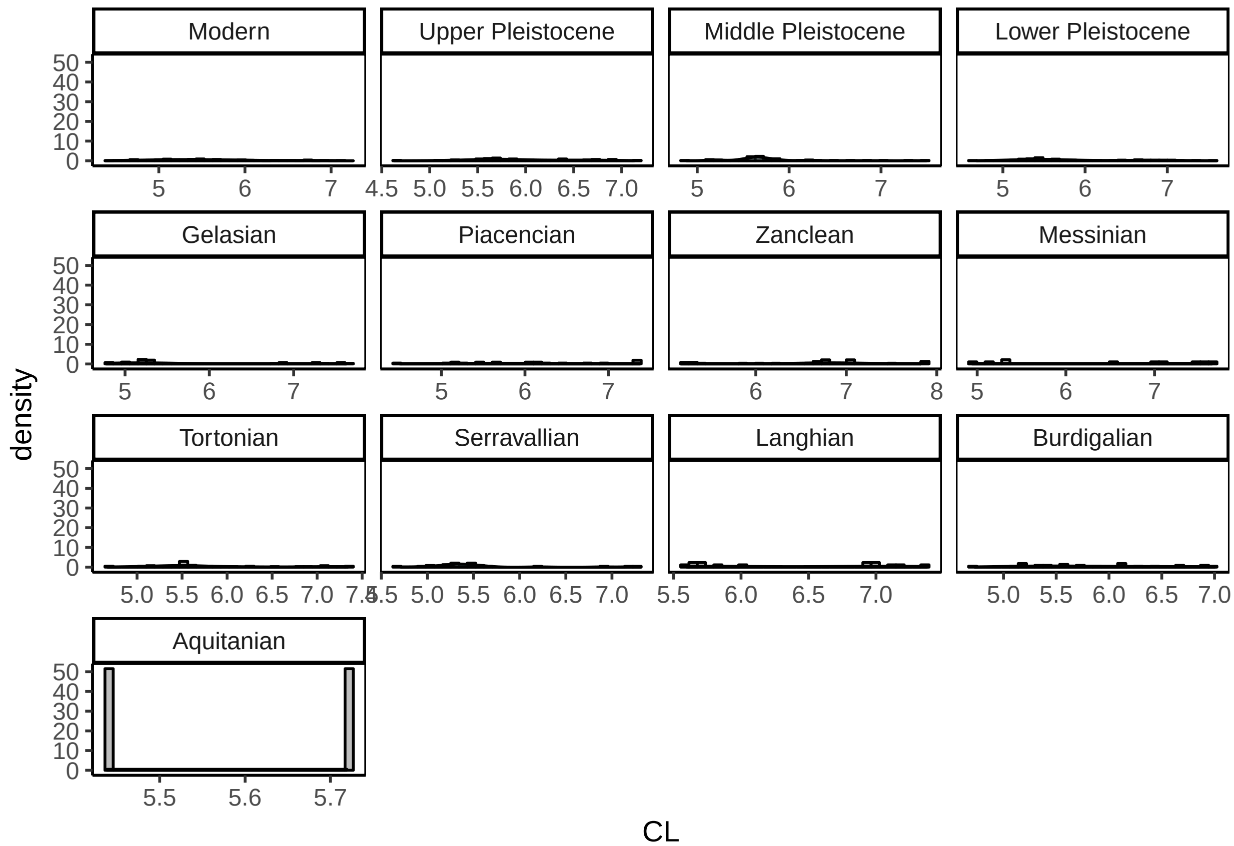


Figure 13: Distribution of body size data per time bin, logtransformed.

modern vs. fossil

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

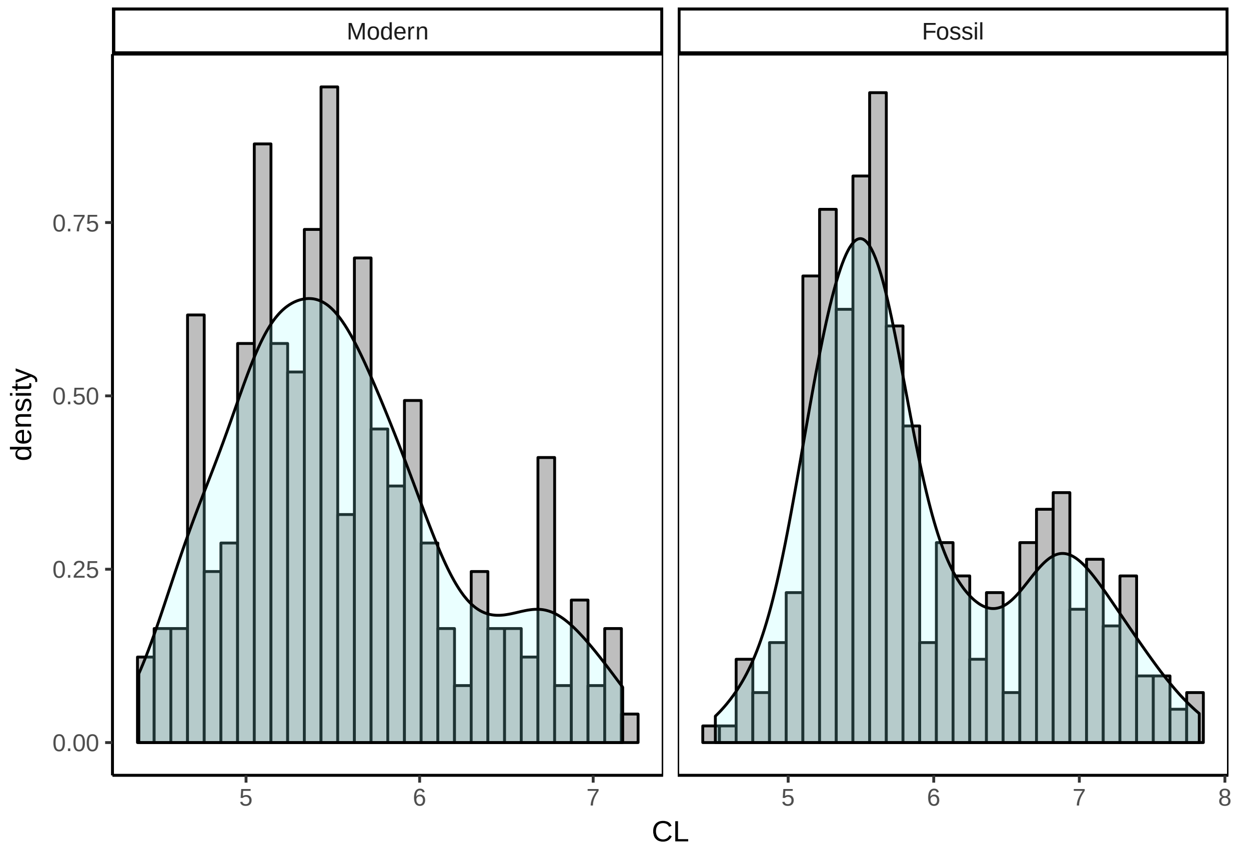


Figure 14: Distribution of body size data modern vs. fossil, logtransformed.

modern vs. fossil, continental vs. insular

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

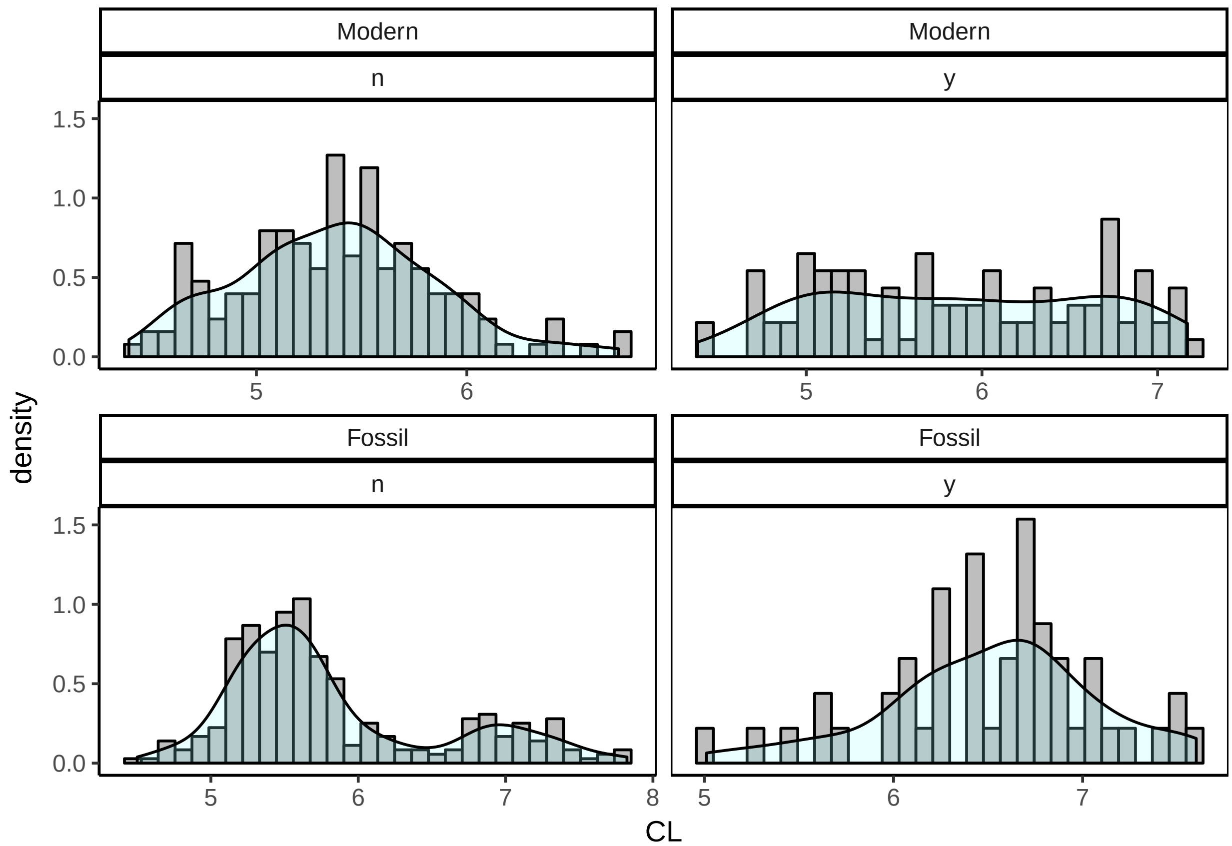


Figure 15: Distribution of body size data modern vs. fossil, continental vs. insular logtransformed.

continental vs. insular

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

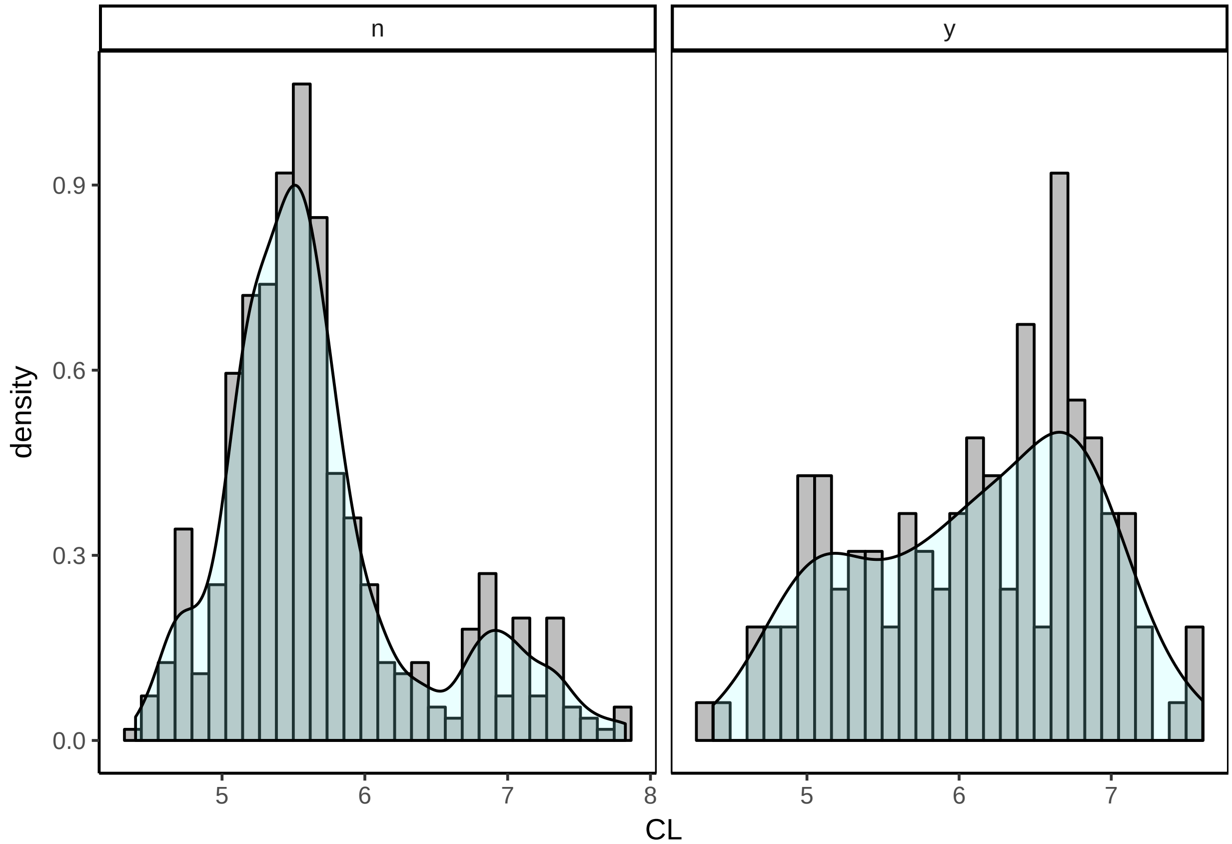


Figure 16: Distribution of body site data of continental (n) and insular(y) species, logtransformed.

continents

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

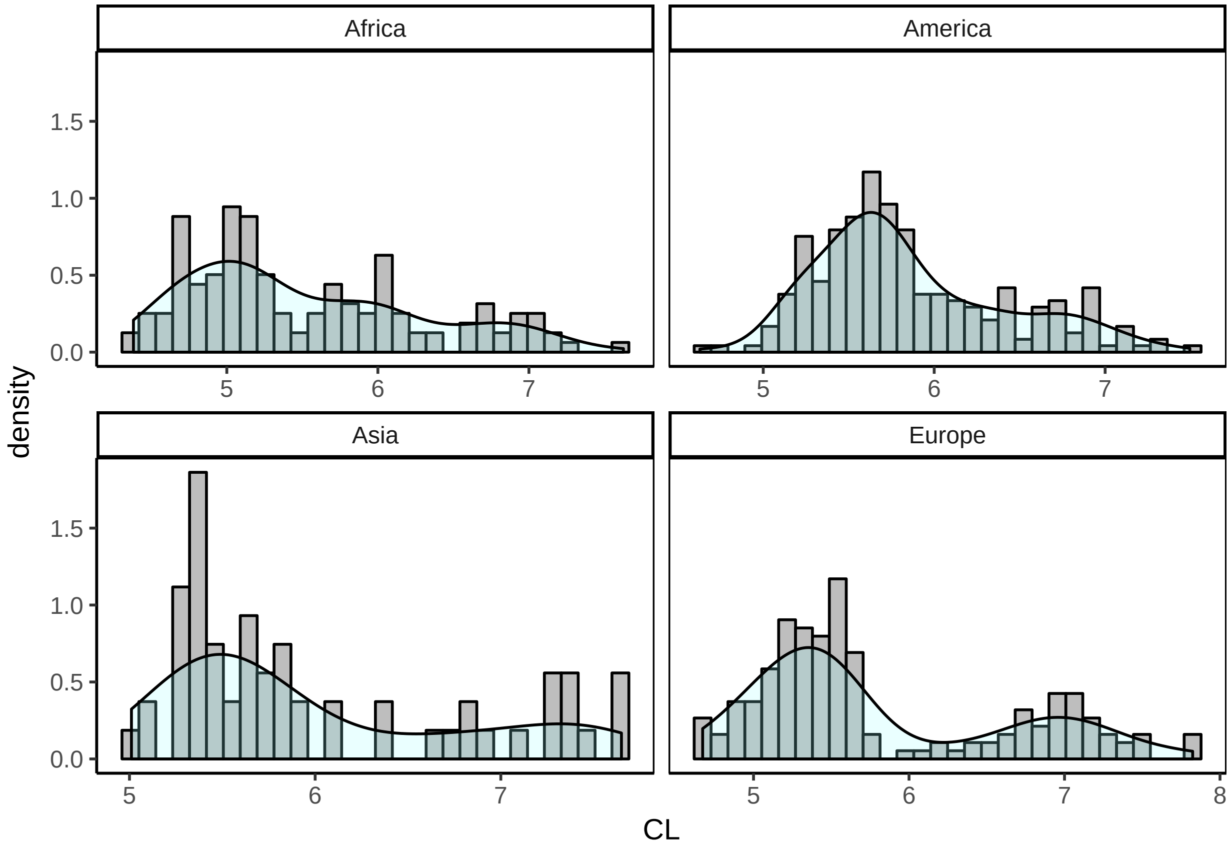


Figure 17: Distribution of body site data per continent, logtransformed.

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
616	80.00	2500.0	164537.800	437.2	2.5	270.5	2.4	2.14	0.69	8.00	2.73	all
253	80.00	1300.0	67485.500	330.3	2.4	242.0	2.4	1.83	0.58	5.87	2.69	Modern
49	102.44	1250.0	69690.660	445.9	2.6	334.7	2.5	1.20	0.24	3.61	2.56	Upper Pleistocene
53	132.00	1800.0	97910.833	387.1	2.5	292.9	2.5	3.03	1.52	12.24	5.55	Middle Pleistocene
57	107.80	2000.0	161948.816	463.5	2.5	263.0	2.4	1.74	0.73	5.76	2.40	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
26	176.00	2500.0	476162.710	955.2	2.9	857.5	2.9	1.11	-0.40	3.56	2.30	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
45	107.00	1540.0	175470.119	462.7	2.5	250.0	2.4	1.49	0.81	3.74	2.54	Tortonian
27	111.00	1500.0	126060.404	337.7	2.4	220.0	2.3	2.49	1.77	7.77	5.30	Serravallian
14	270.00	1600.0	230451.330	747.9	2.8	700.0	2.8	0.30	0.03	1.55	1.18	Langhian
28	113.00	1100.0	80293.821	416.7	2.5	305.0	2.5	1.16	0.37	3.18	2.13	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
253	80.00	1300.0	67485.500	330.3	2.4	242.0	2.4	1.83	0.58	5.87	2.69	Modern
363	90.00	2500.0	219004.661	511.7	2.6	285.6	2.5	1.83	0.68	6.11	2.42	Fossil
469	81.00	2500.0	157808.792	392.9	2.5	250.0	2.4	2.65	1.07	10.57	3.74	continental
147	80.00	2000.0	160834.346	578.5	2.6	500.0	2.7	1.02	-0.27	3.95	2.05	insular
157	81.00	830.0	17009.024	244.0	2.3	221.0	2.3	1.92	0.29	8.09	2.98	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
312	90.00	2500.0	212116.787	467.9	2.5	270.0	2.4	2.11	0.96	7.25	2.96	fossil-con
51	150.00	2000.0	180825.399	780.0	2.8	750.0	2.9	1.11	-0.40	4.02	3.18	fossil-ins
142	80.00	2050.0	112417.261	347.7	2.4	193.5	2.3	2.10	0.68	7.97	2.48	Africa
242	102.44	1800.0	82209.709	415.0	2.5	302.2	2.5	1.92	0.75	6.79	2.91	America
59	150.00	2100.0	323123.197	585.5	2.6	280.0	2.4	1.43	0.85	3.61	2.24	Asia

nCL	min	max	var	mean	logm	med	logmed	skew	logsk	kurt	logku	Variable
173	107.00	2500.0	254222.839	491.2	2.5	245.0	2.4	1.86	0.81	6.30	2.34	Europe

Boxplots

genera per time bins

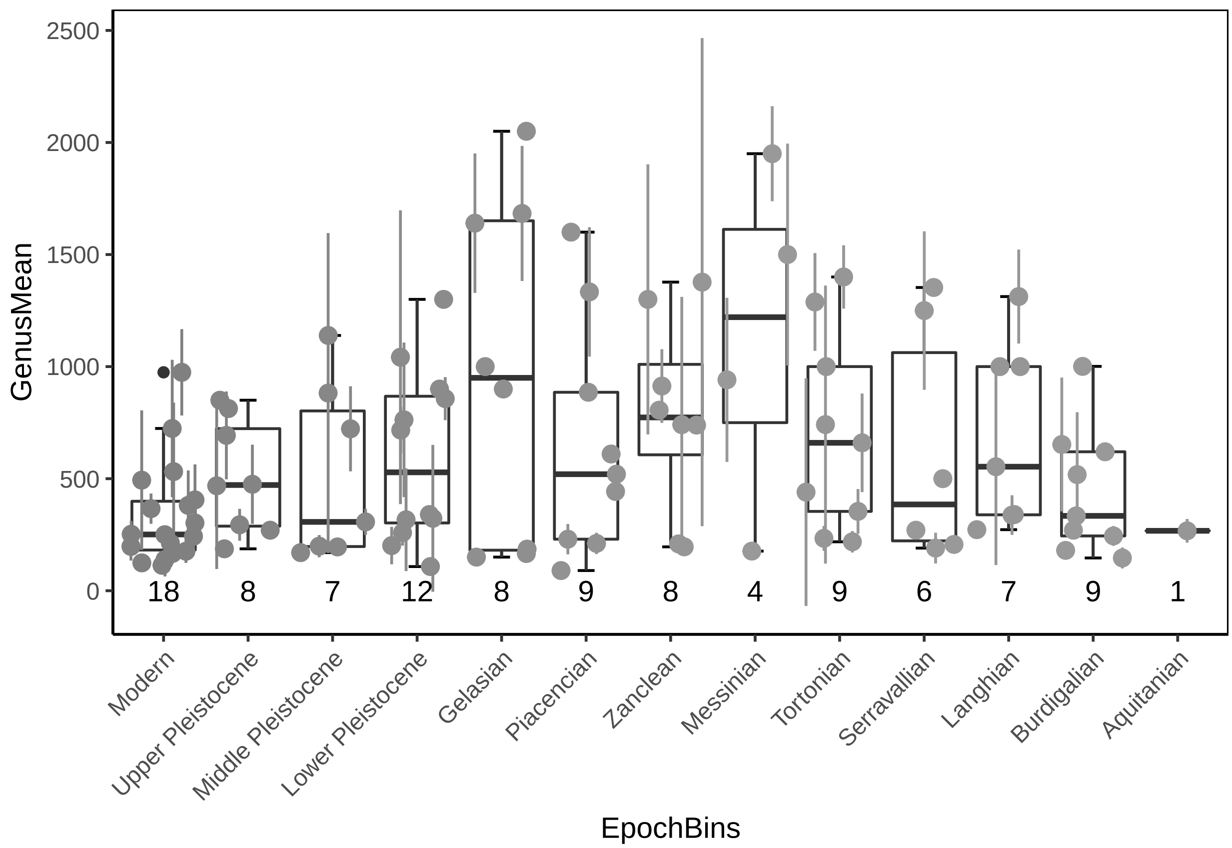


Figure 18: Boxplots of mean CL per time bin, including mean and sd CL for each genus (as pointrange).

continental vs. insular per time bin

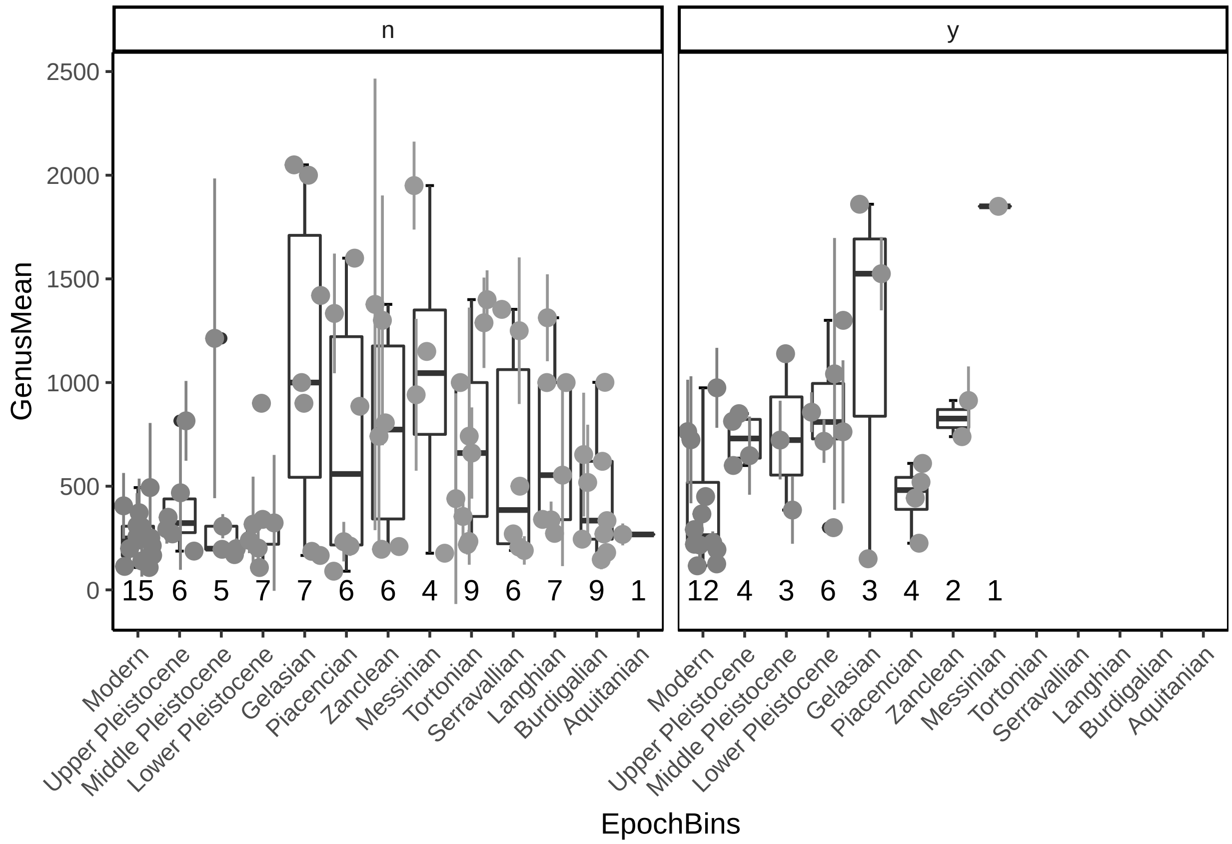


Figure 19: Boxplots of each genus per time bin, continental vs. insular species.

fossil vs. modern

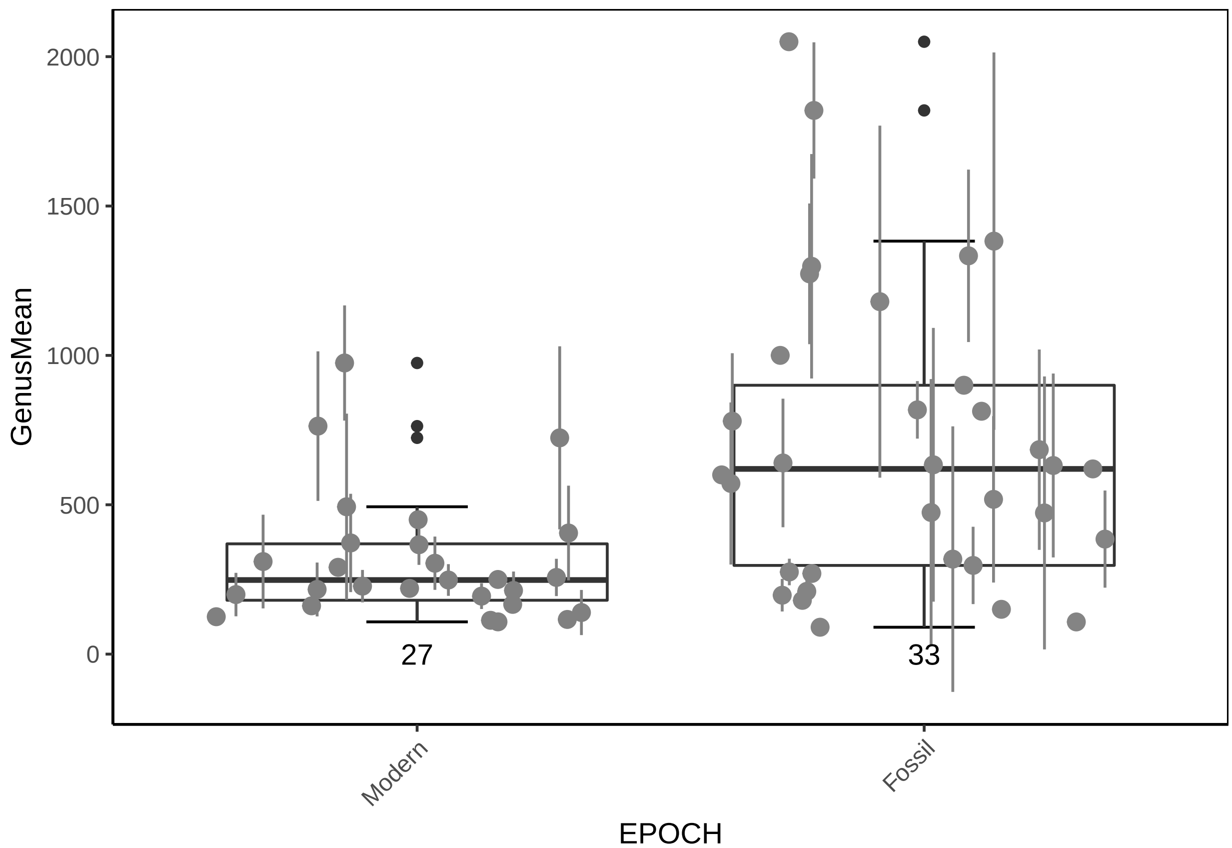
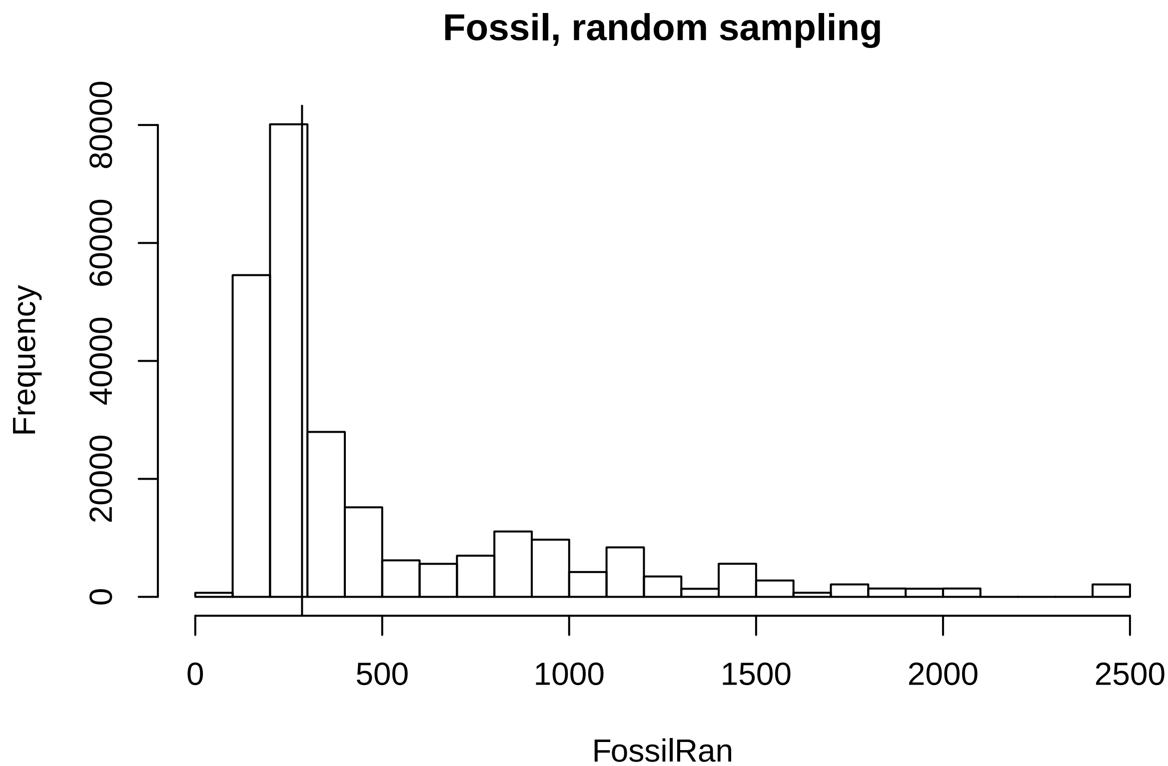


Figure 20: Boxplots fossil vs. modern.




```
## [1] 330.3495

## [1] 478.4724

##
##  Wilcoxon rank sum test with continuity correction
##
## data:  Modern and Fossil
## W = 24708, p-value = 8.224e-06
## alternative hypothesis: true location shift is less than 0
```

Wilcoxon Rank Sum Test (unpaired data):

modern < fossil (P = 8.2236647×10^{-6})

fossil vs. modern, continental vs. insular

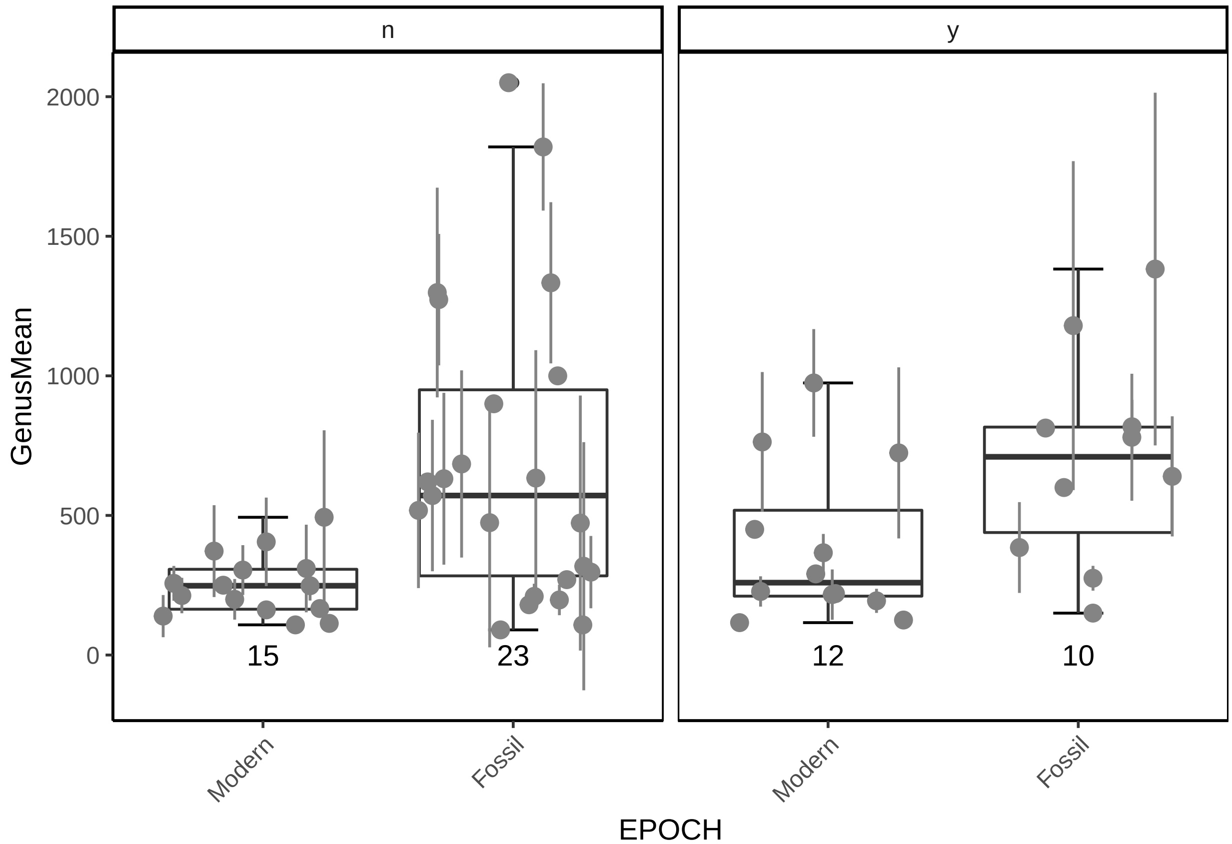
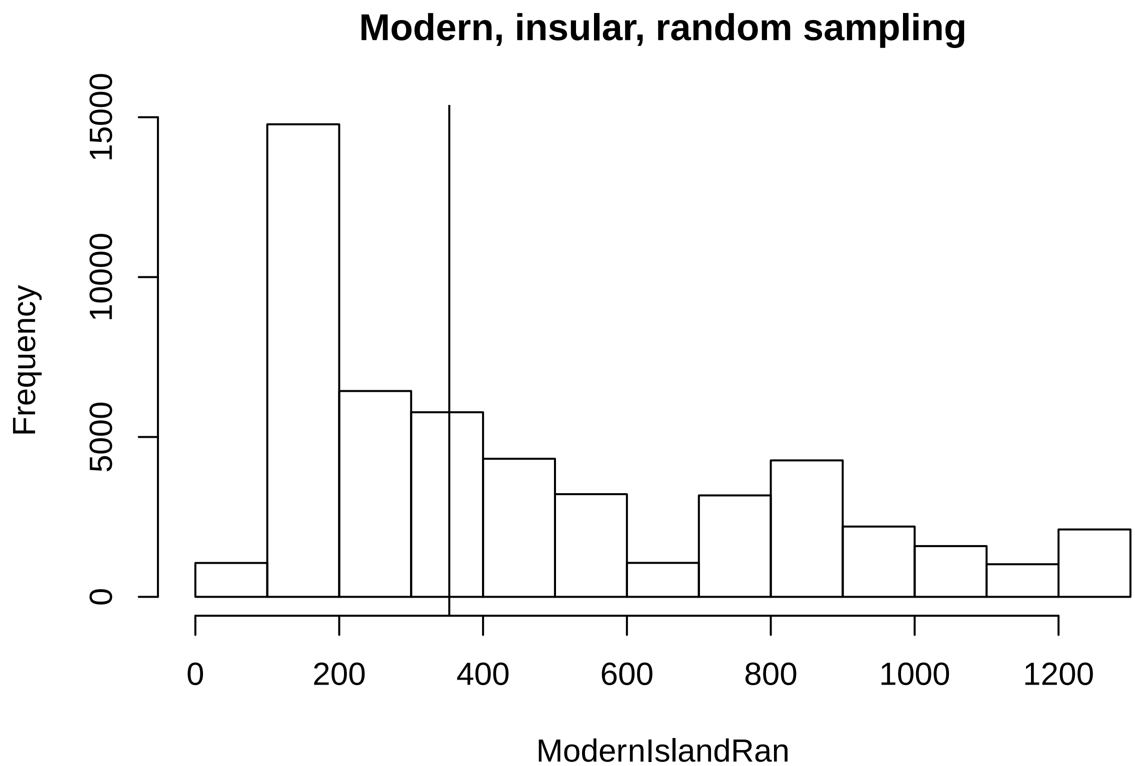


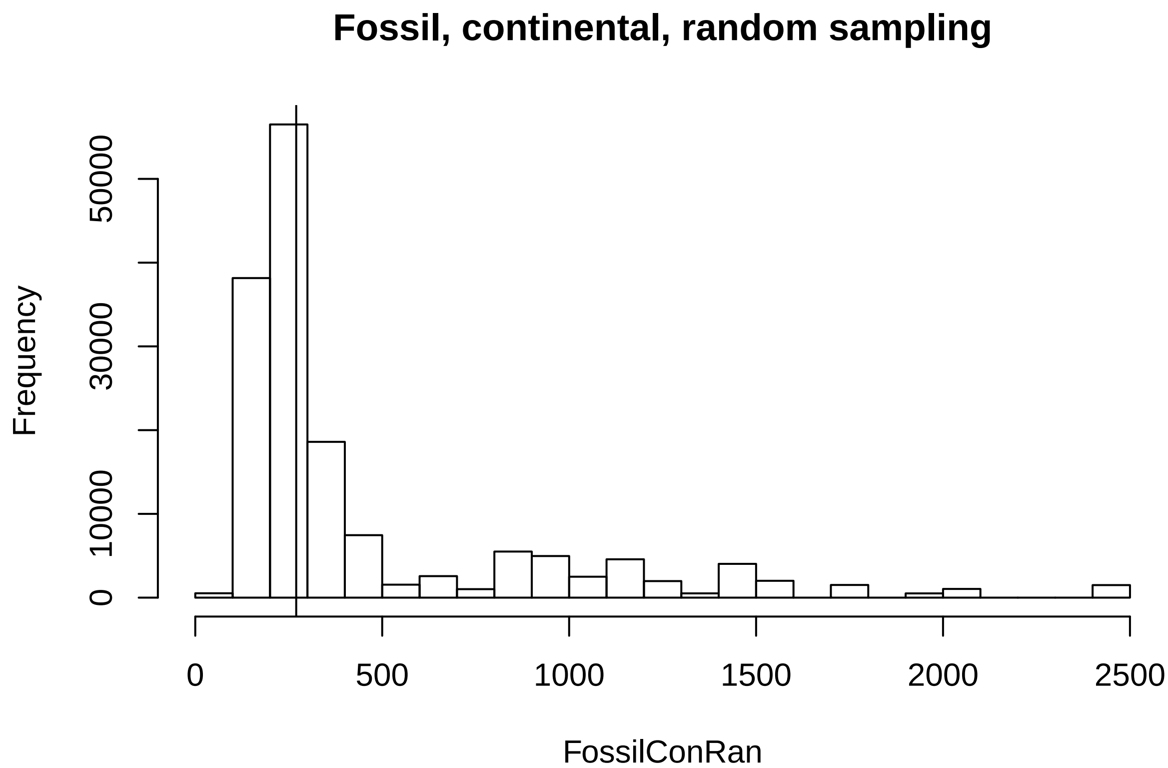
Figure 21: Boxplots fossil vs. modern, continental vs. insular species.

```
## [1] 51
```

```
## [1] 51
```




```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  ModernIsland and FossilIsland
## W = 640.5, p-value = 5.067e-06
## alternative hypothesis: true location shift is less than 0

## [1] 157

## [1] 157
```




```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  ModernCon and FossilCon
## W = 8050, p-value = 5.377e-08
## alternative hypothesis: true location shift is less than 0
```

Wilcoxon Rank Sum Test (unpaired data):

modern continental < fossil continental ($P = 5.3770913 \times 10^{-8}$)

modern insular < fossil insular ($P = 5.0665217 \times 10^{-6}$)

continental vs. insular

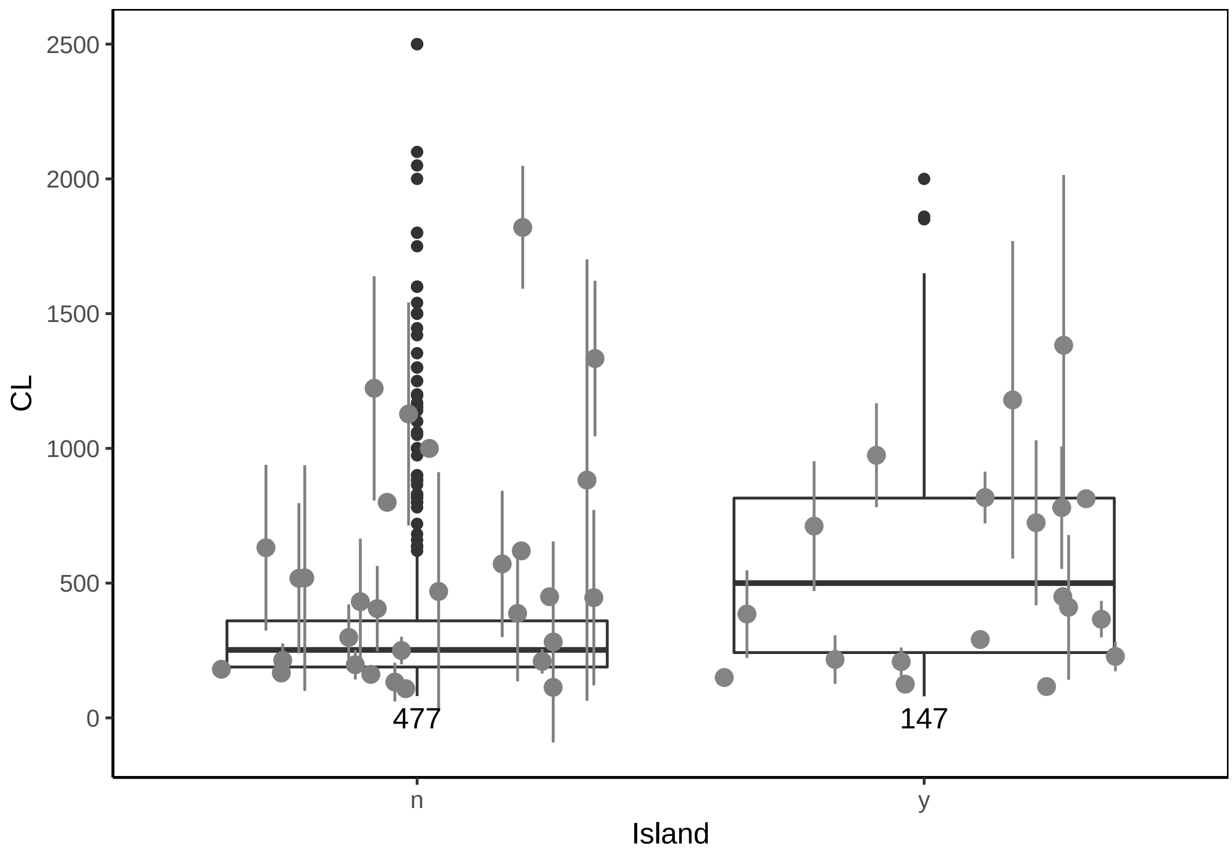
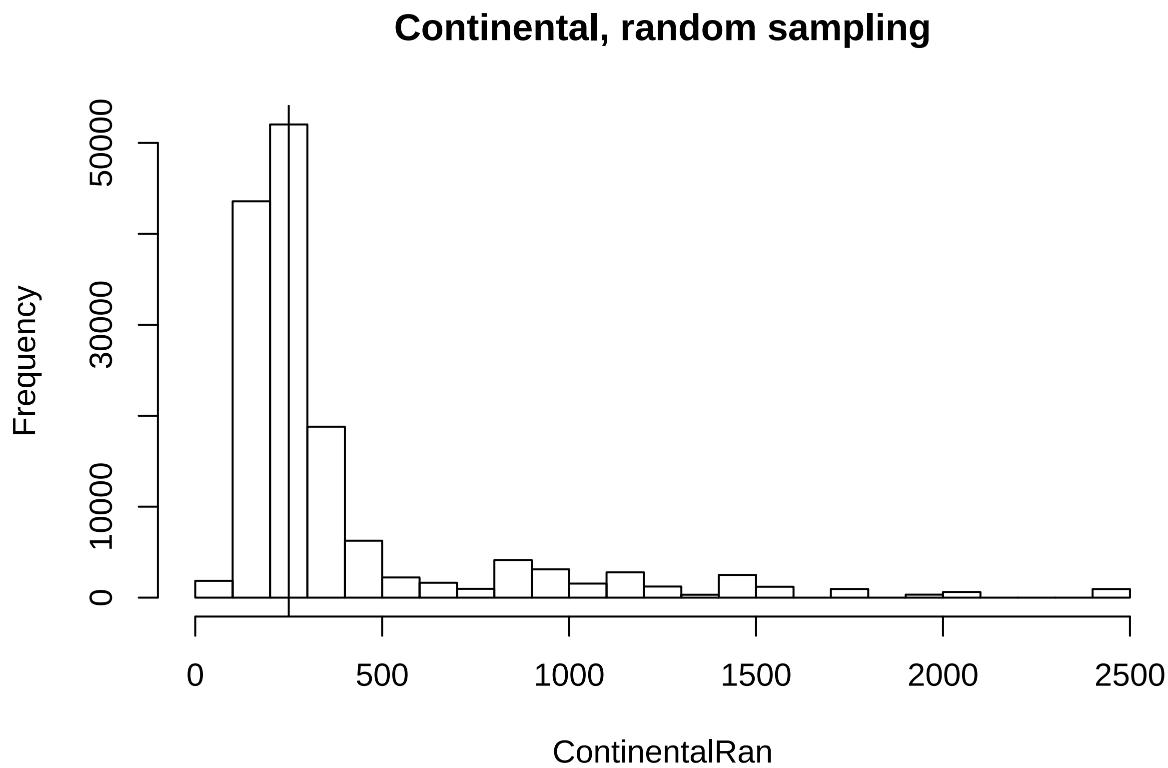


Figure 22: Boxplot continental vs. insular, genera summarised

```
## [1] 147
```

```
## [1] 147
```




```
##
##  Wilcoxon rank sum test with continuity correction
##
## data:  Insular and Continental
## W = 14470, p-value = 2.47e-07
## alternative hypothesis: true location shift is greater than 0
```

Wilcoxon Rank Sum Test (unpaired data):

continental < insular ($P = 2.4702259 \times 10^{-7}$)

continental vs. insular per time bin

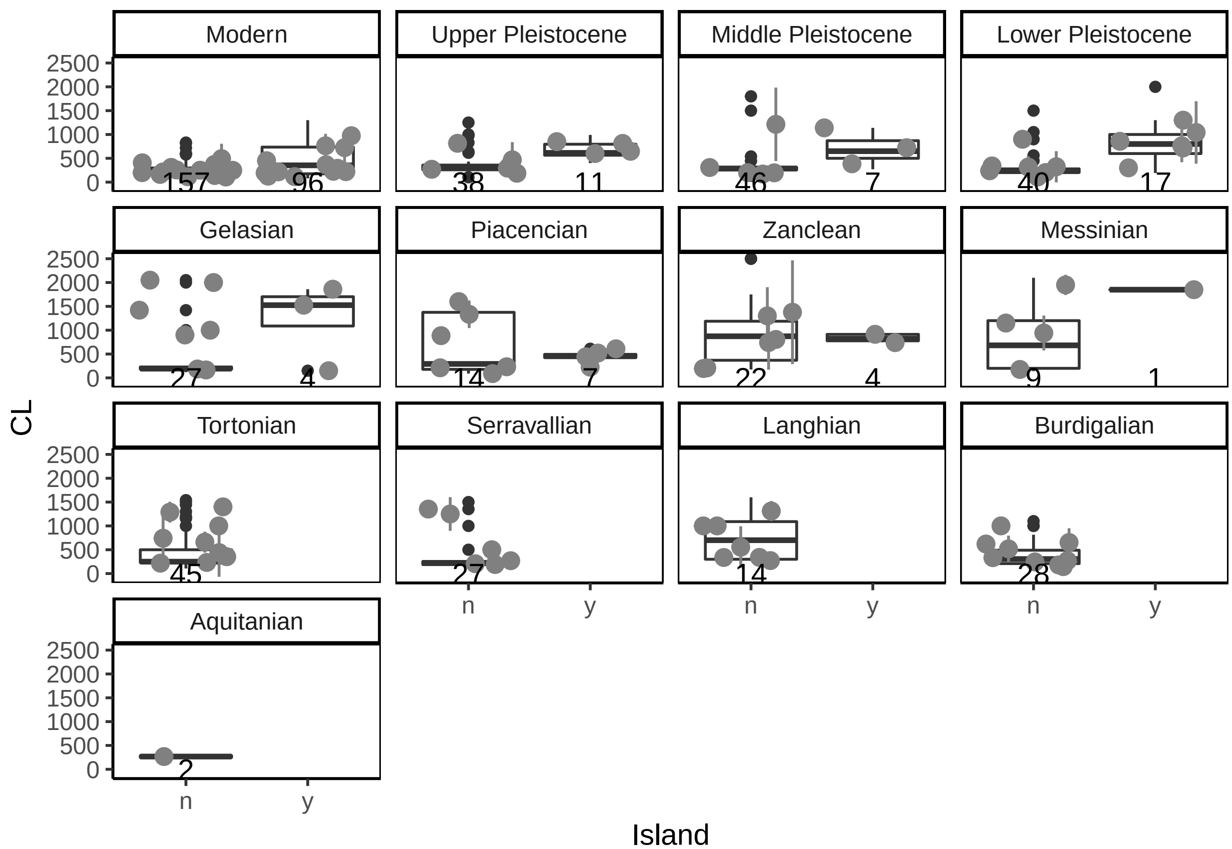


Figure 23: Boxplot continental vs. insular, genera summarised

continents

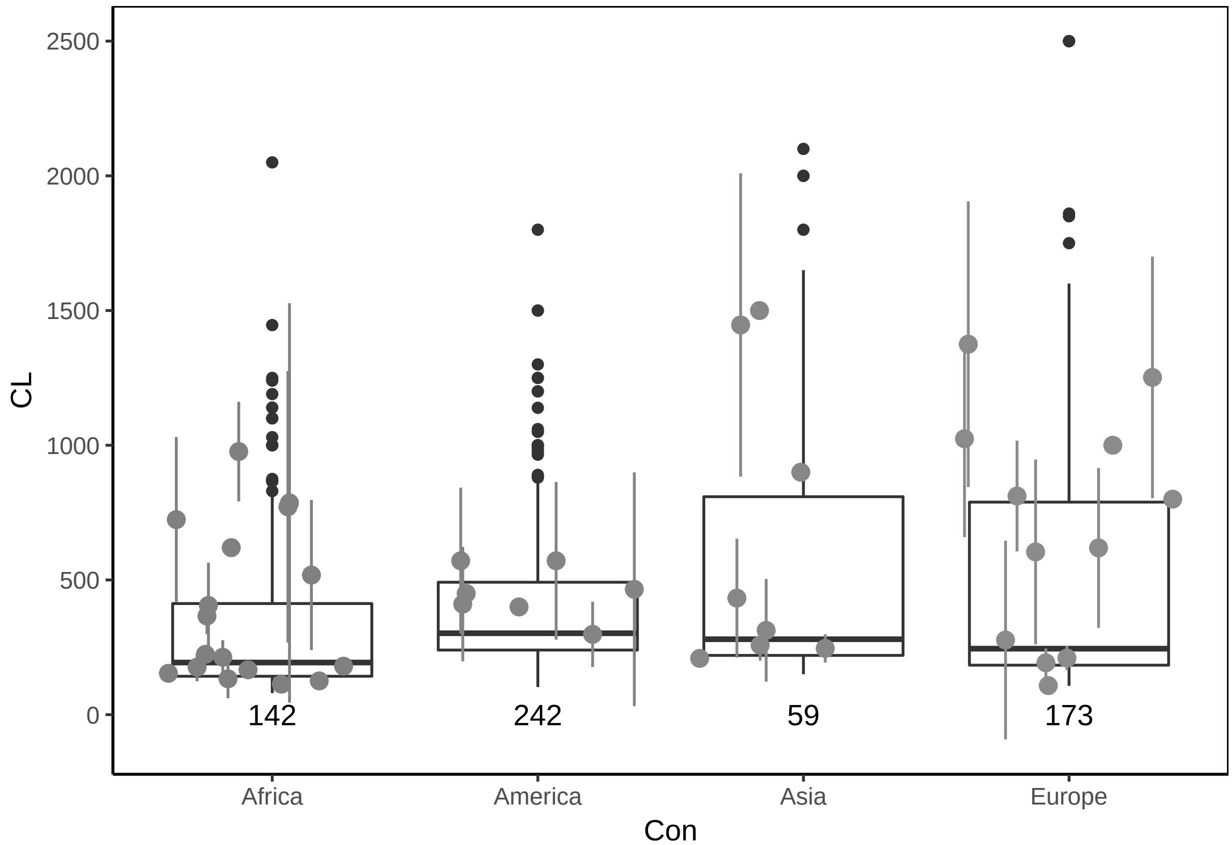
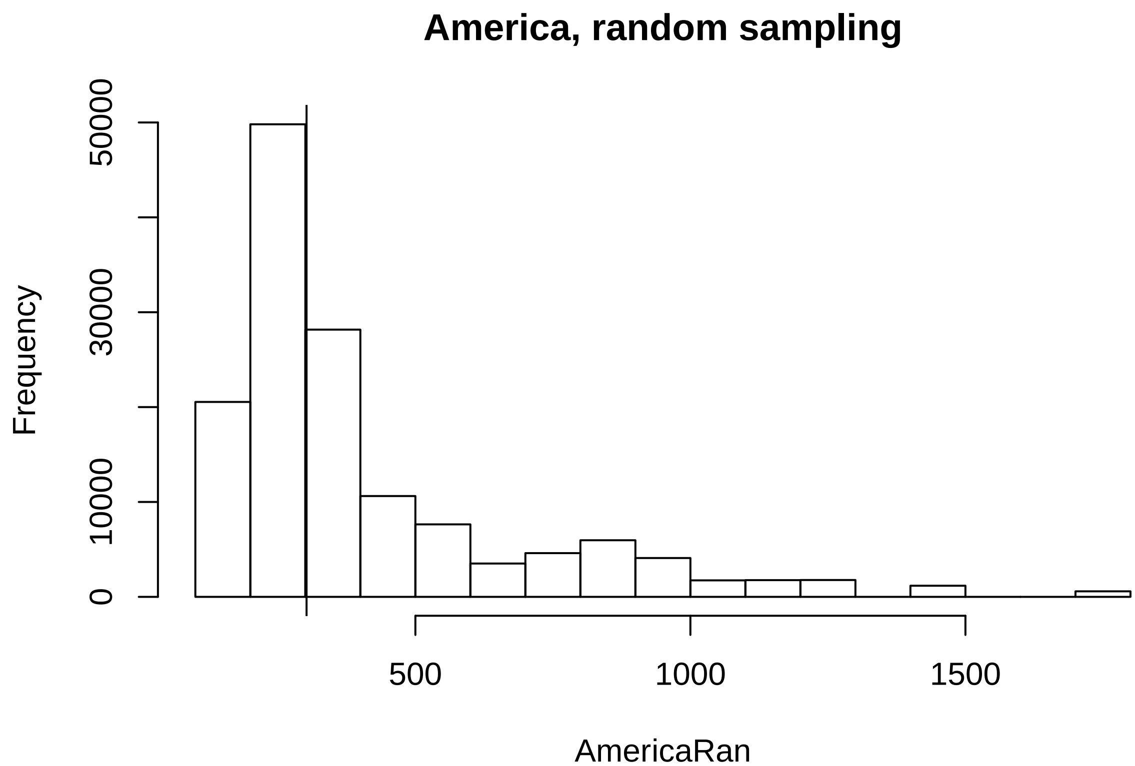
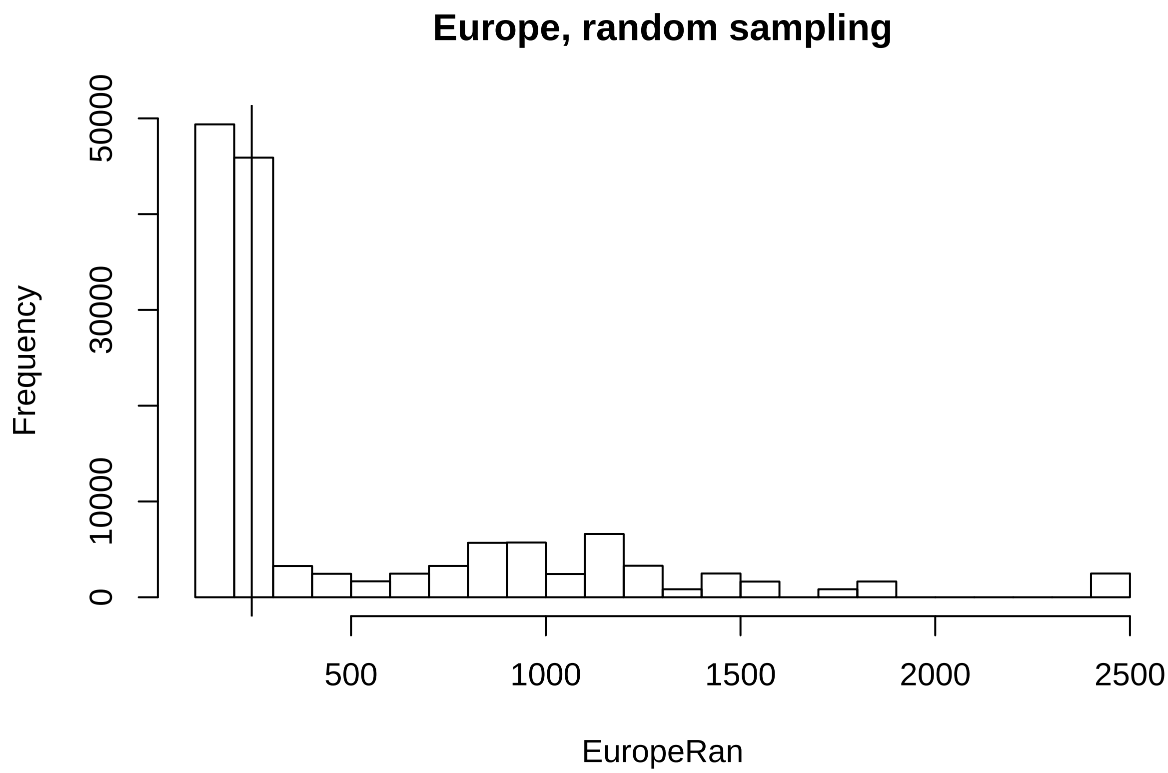
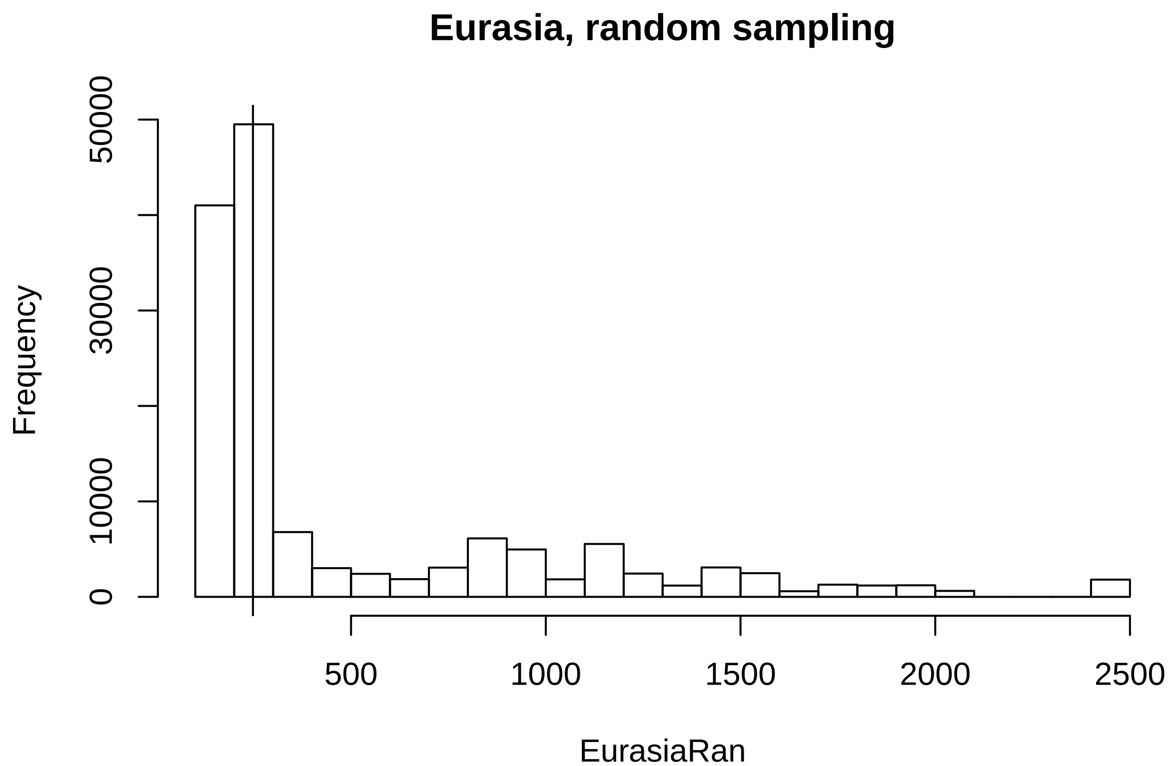


Figure 24: Boxplot: body size on different continents, genera summarised

```
## [1] 142

## [1] 347.6887

## [1] 142

## [1] 423.6606

## [1] 59

## [1] 173

## [1] 142

## [1] 480.0239
```


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 = 32.761, df = 3, p-value = 3.618e-07
```

Kruskal-Wallis-Test:

Continent means differ (P $= 3.6175292 \times 10^{-7}$) (still have to look into the details. . .)

continents, continental vs. insular

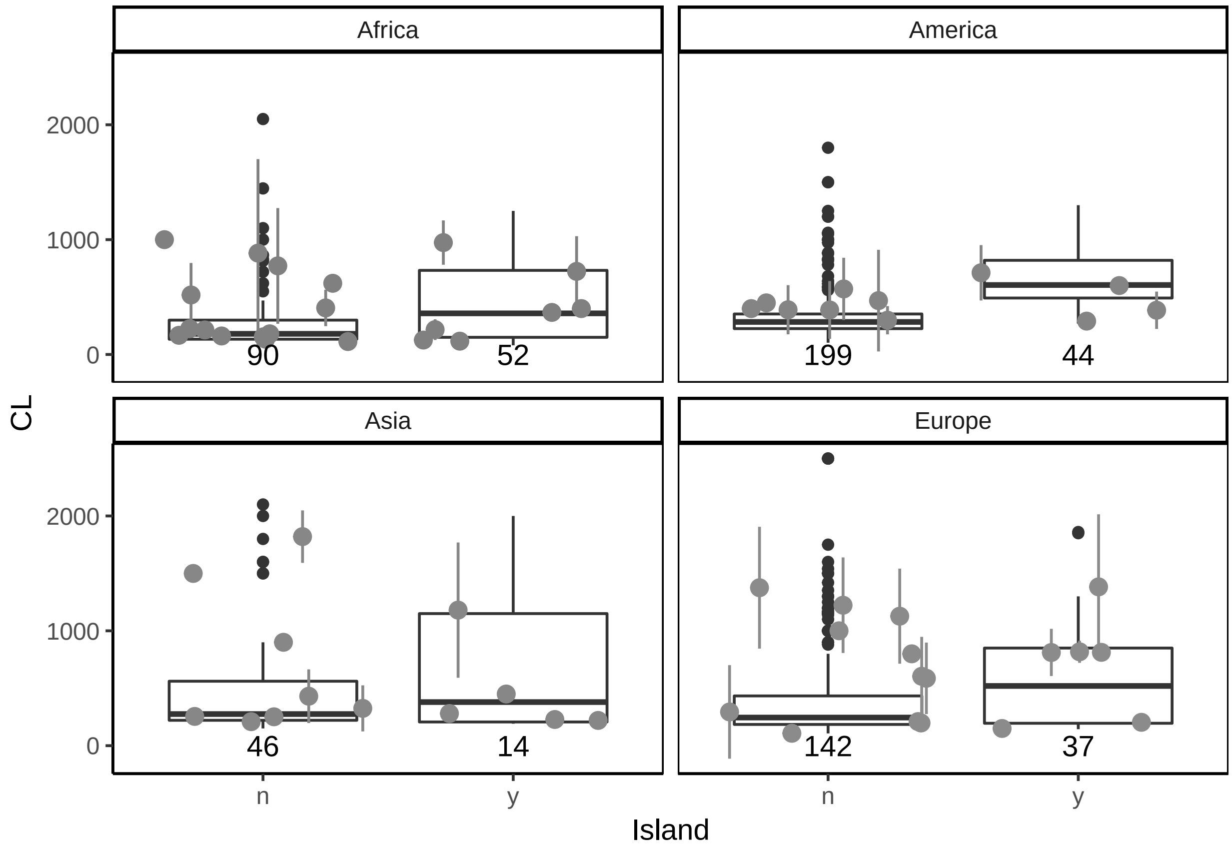


Figure 25: Boxplot: body size on different continents, genera summarised

paleoTS analysis

all (continental and insular)

genera (all)

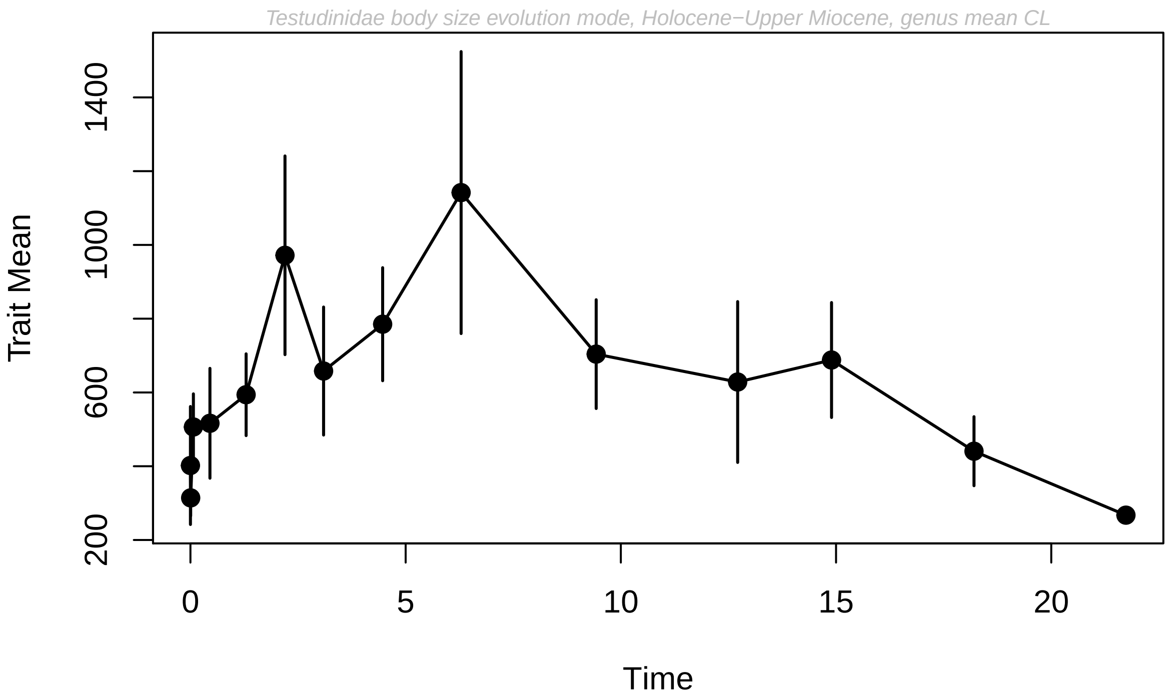


Figure 26: paleoTS plot with genus mean, including island species

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

	logL	K	AICc	Akaike.wt
GRW	-86.99386	2	179.1877	0.461
URW	-88.57811	1	179.5199	0.390
Stasis	-88.12362	2	181.4472	0.149

continental (excluding insular species)

genera (continental)

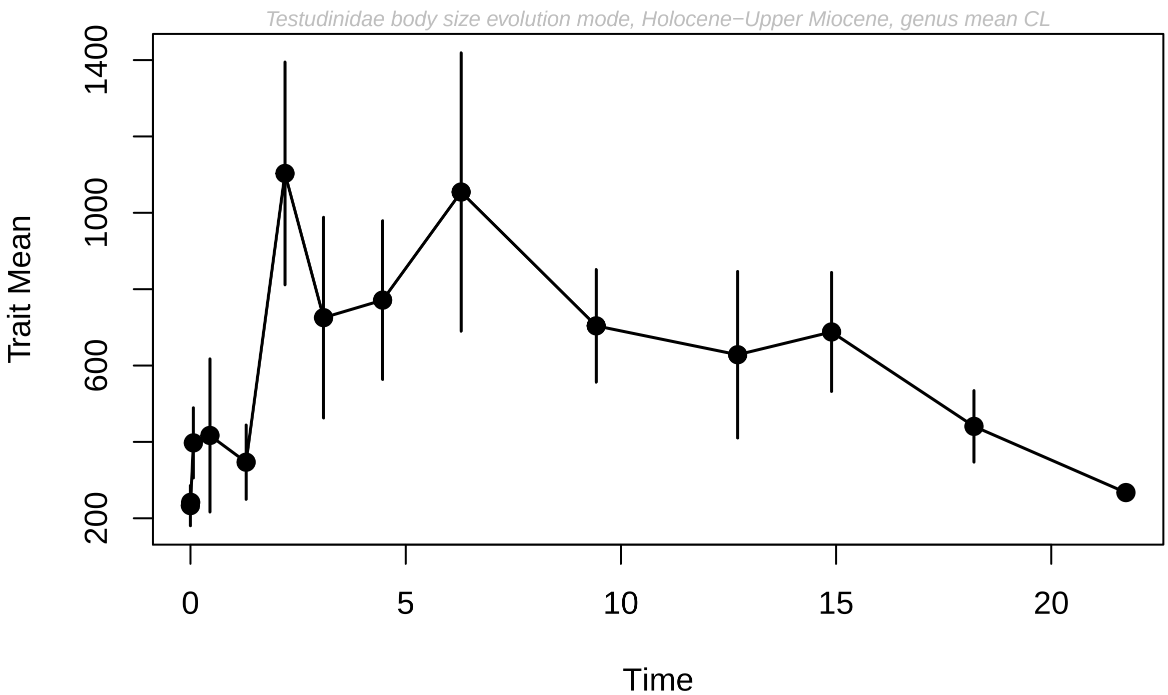


Figure 27: paleoTS plot with genus mean, excluding island species

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

	logL	K	AICc	Akaike.wt
GRW	-87.90745	2	181.0149	0.537
URW	-89.62953	1	181.6227	0.397
Stasis	-90.00652	2	185.2130	0.066

insular (excluding continental)

genera (insular)

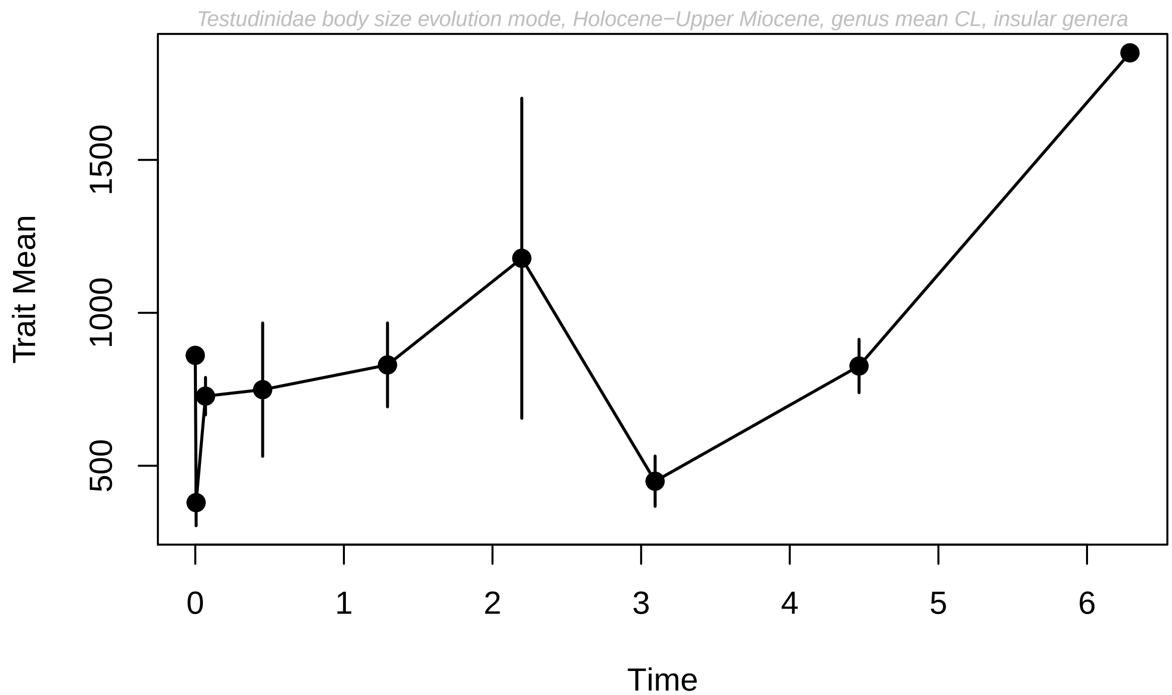


Figure 28: paleoTS plot with genus mean, only insular species

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

	logL	K	AICc	Akaike.wt
GRW	-68.57344	2	143.5469	0
URW	-75.76576	1	154.1982	0
Stasis	-60.41581	2	127.2316	1

per continent

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

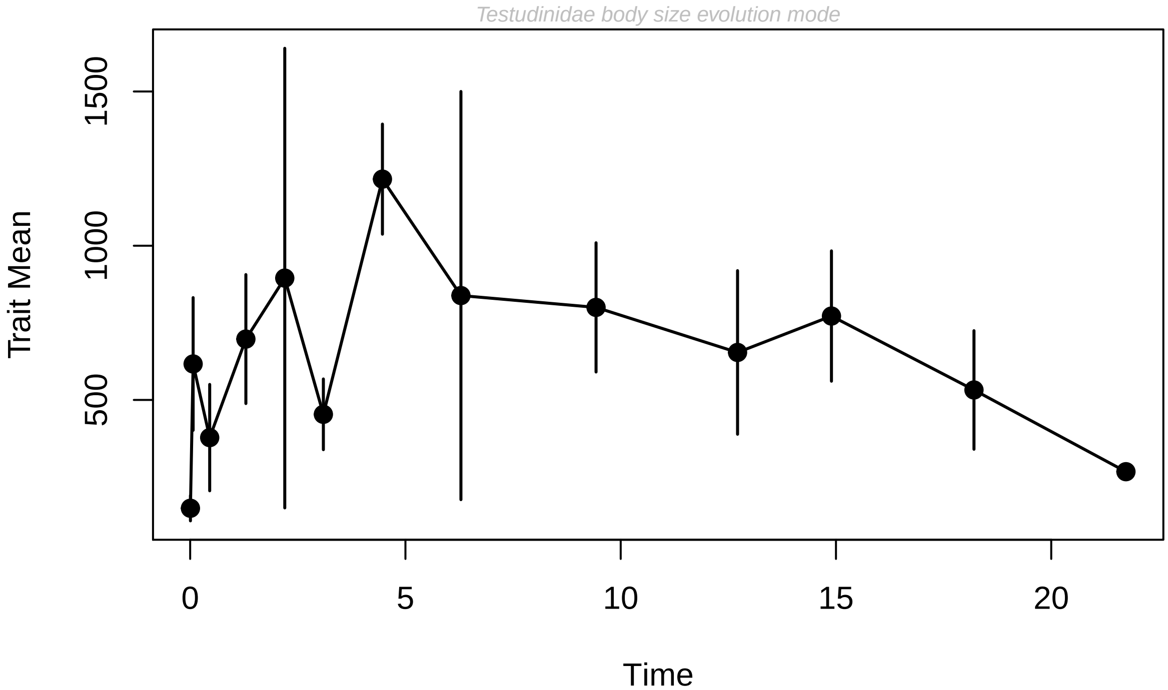


Figure 29: Smaller original bins, genera, Europe

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

	logL	K	AICc	Akaike.wt
GRW	-93.41355	2	192.1604	0.003
URW	-93.53232	1	189.4646	0.012
Stasis	-87.65688	2	180.6471	0.985

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

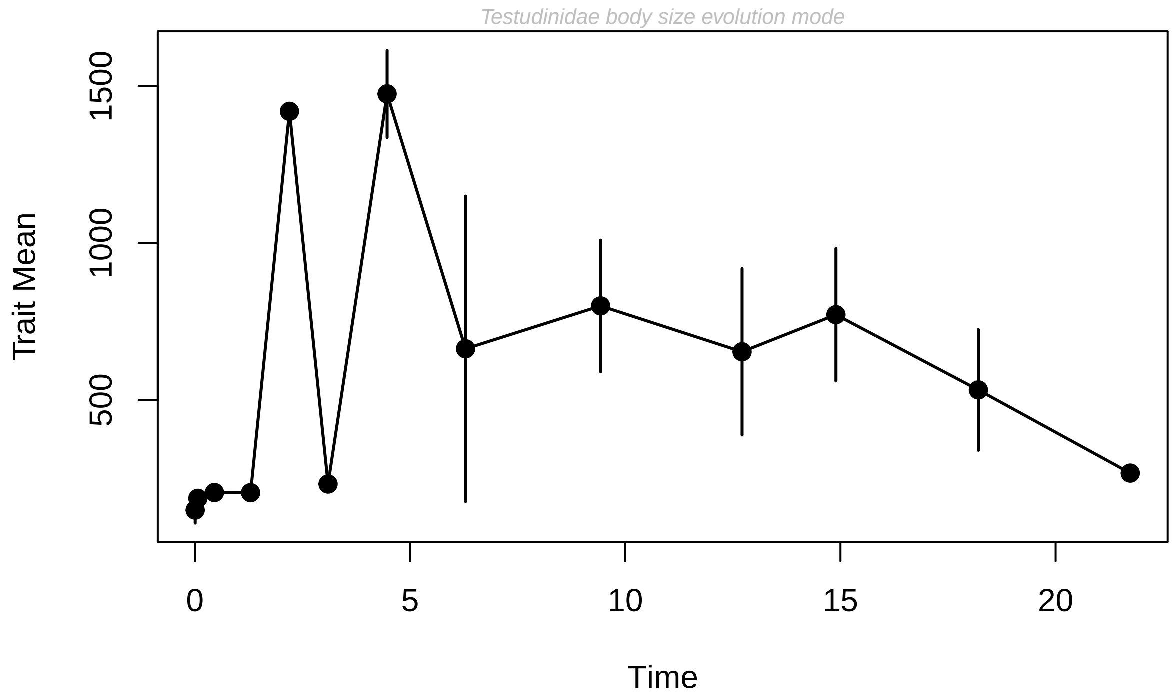


Figure 30: Smaller original bins, genera, Europe, continental

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

	logL	K	AICc	Akaike.wt
GRW	-95.85309	2	197.0395	0.005
URW	-101.78239	1	205.9648	0.000
Stasis	-90.54653	2	186.4264	0.995

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

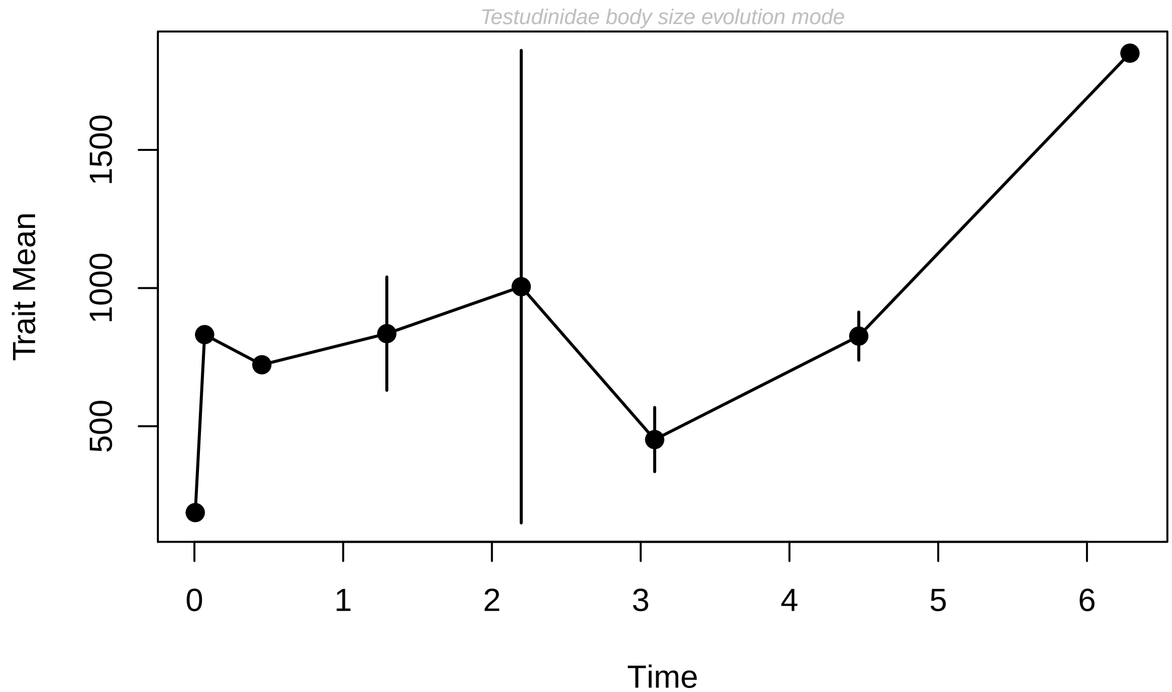


Figure 31: Smaller original bins, genera, Europe, insular

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

	logL	K	AICc	Akaike.wt
GRW	-67.12192	2	141.2438	0.000
URW	-57.51634	1	117.8327	0.074
Stasis	-52.89638	2	112.7928	0.926

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

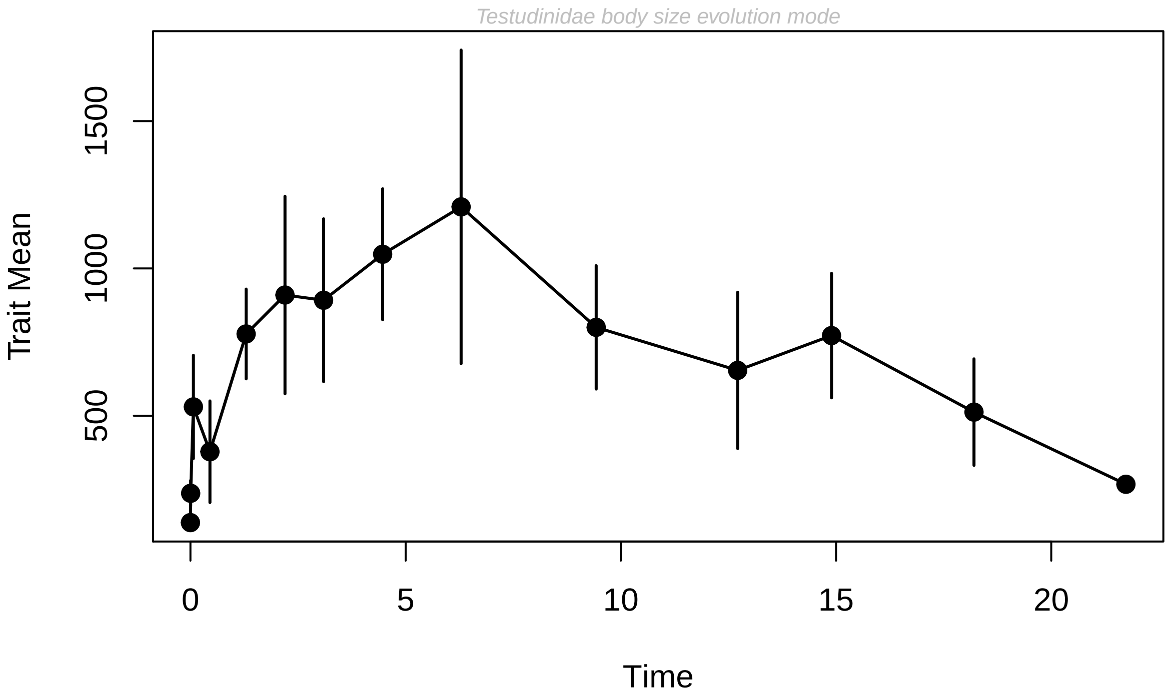


Figure 32: Smaller original bins, genera, Eurasia

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

	logL	K	AICc	Akaike.wt
GRW	-91.65642	2	188.5128	0.286
URW	-92.43040	1	187.2244	0.545
Stasis	-92.18096	2	189.5619	0.169

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

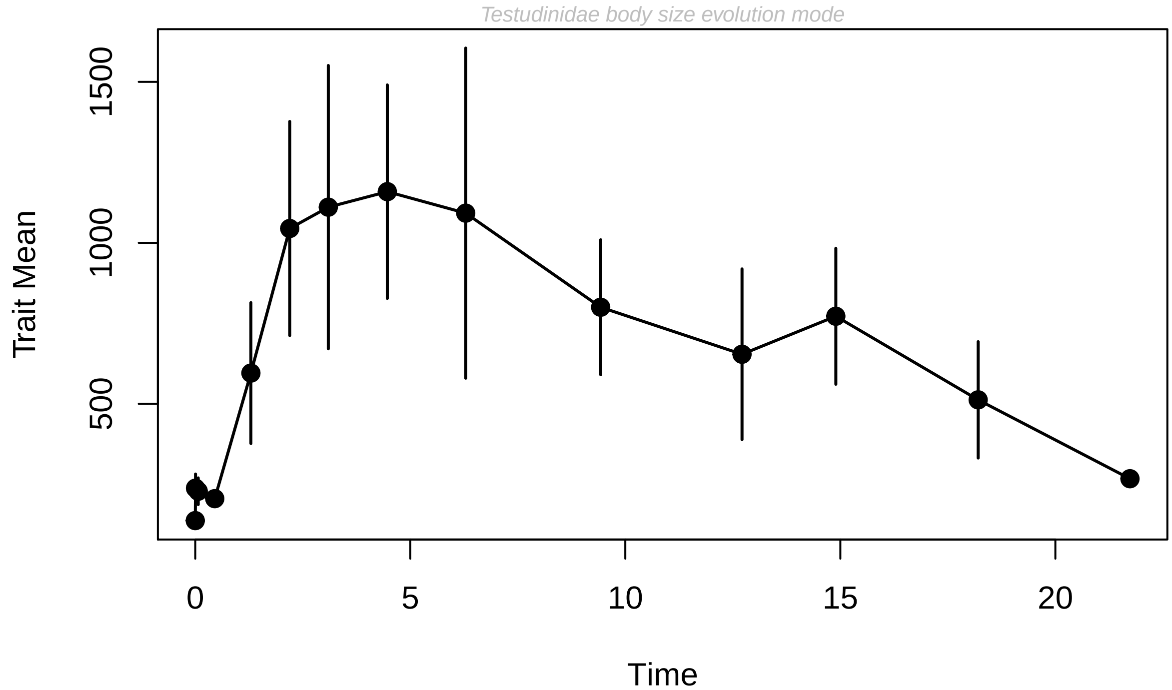


Figure 33: Smaller original bins, genera, Eurasia, continental

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

	logL	K	AICc	Akaike.wt
GRW	-88.58343	2	182.3669	0.368
URW	-89.46313	1	181.2899	0.631
Stasis	-94.20845	2	193.6169	0.001

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

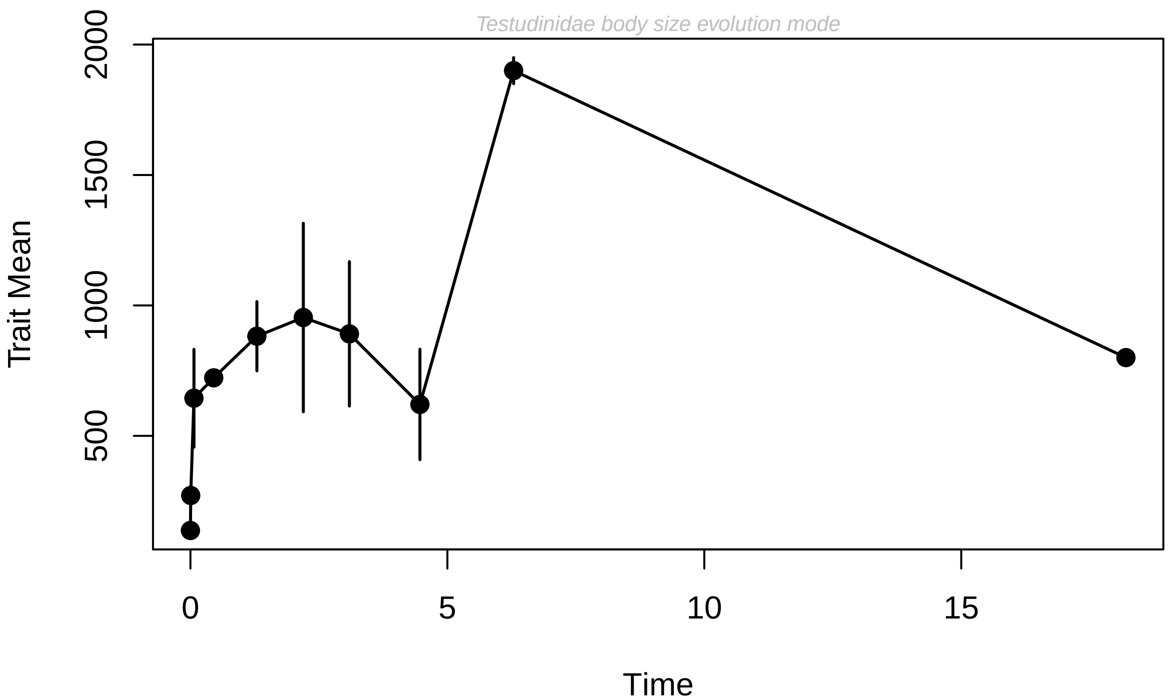


Figure 34: Smaller original bins, genera, Eurasia, insular

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

	logL	K	AICc	Akaike.wt
GRW	-69.52635	2	145.0527	0.194
URW	-71.47418	1	145.5198	0.153
Stasis	-68.31026	2	142.6205	0.653