MAthesis

Contents

Time bins (stratigraphic stages) **2**

Maps **4**

fossil occurences of testudinidae 4

body size of testudinidae 5

Sampling Accumulation Curve **6**

Eurasia 7

Histograms **8**

all 8

per time bin 11

modern vs. fossil 12

modern vs. fossil, continental vs. insular 13

continental vs. insular 14

continents 15

General statistics 16

Boxplots **18**

genera per time bins 18

continental vs. insular per time bin 19

fossil vs. modern 20

fossil vs. modern, continental vs. insular 22

continental vs. insular 24

continental vs. insular per time bin 26

continents 27

continents, continental vs. insular 29

paleoTS analysis **30**

all (continental and insular) 30

continental (excluding insular species) 31
insular (excluding continental) 32
per continent 33

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	48	16	8
(0.126,0.781]	Middle Pleistocene	Middle Pleistocene	0.45350	52	12	7
(0.781,1.81]	Lower Pleistocene	Lower Pleistocene	1.29350	53	23	11
(1.81,2.59]	Gelasian	Lower Pleistocene	2.19700	29	11	8
(2.59,3.6]	Piacencian	Upper Pliocene	3.09400	23	14	9
(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	45	19	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
```

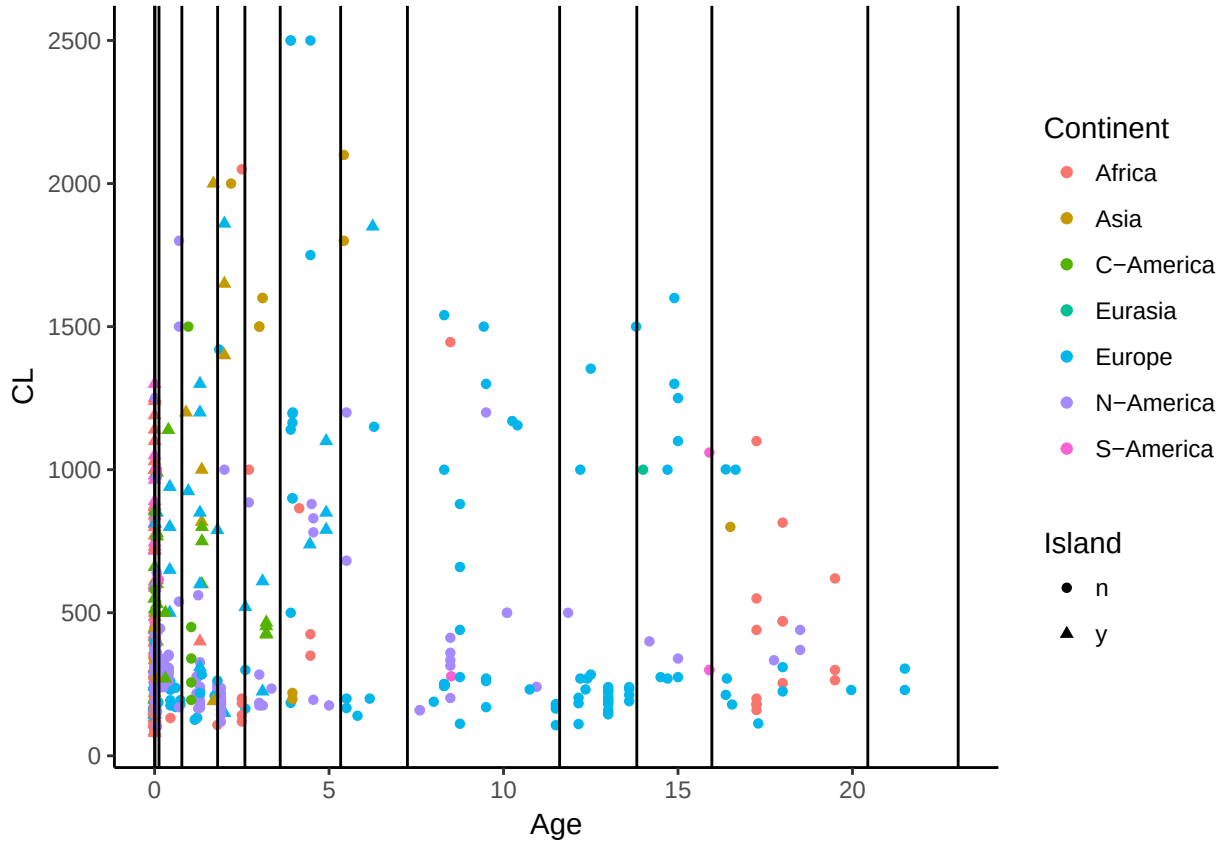


Figure 1: Scatterplot of CL over time, indicating insular (triangle) and continental (circles) and colour indicating continents. Lines indicte bins, dashed line = new bins.

Maps

fossil occurences of testudinidae

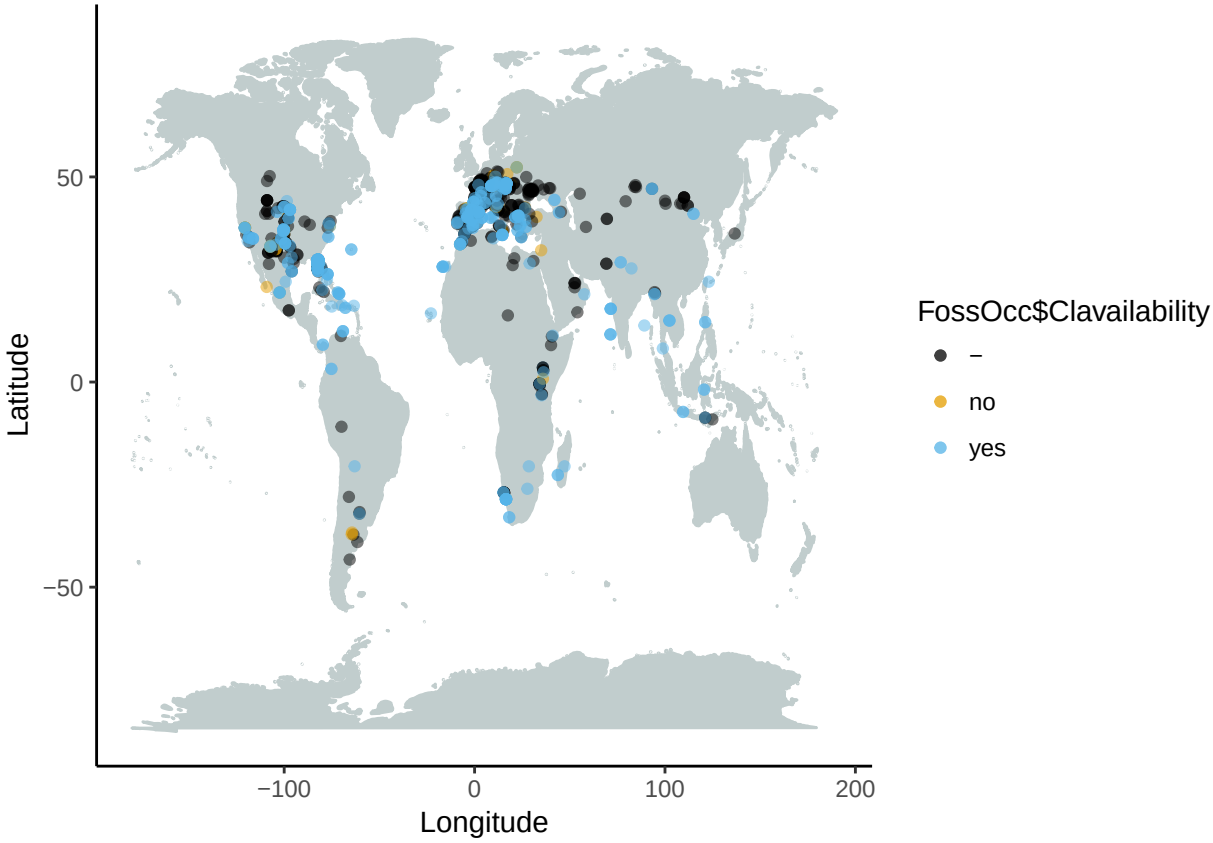


Figure 2: Map displaying all fossil occurrences of testudinids, with color indicating whether relevant literature was available (black if not) and if it was, whether body size data was available or not (yes and no, respectively).

body size of testudinidae

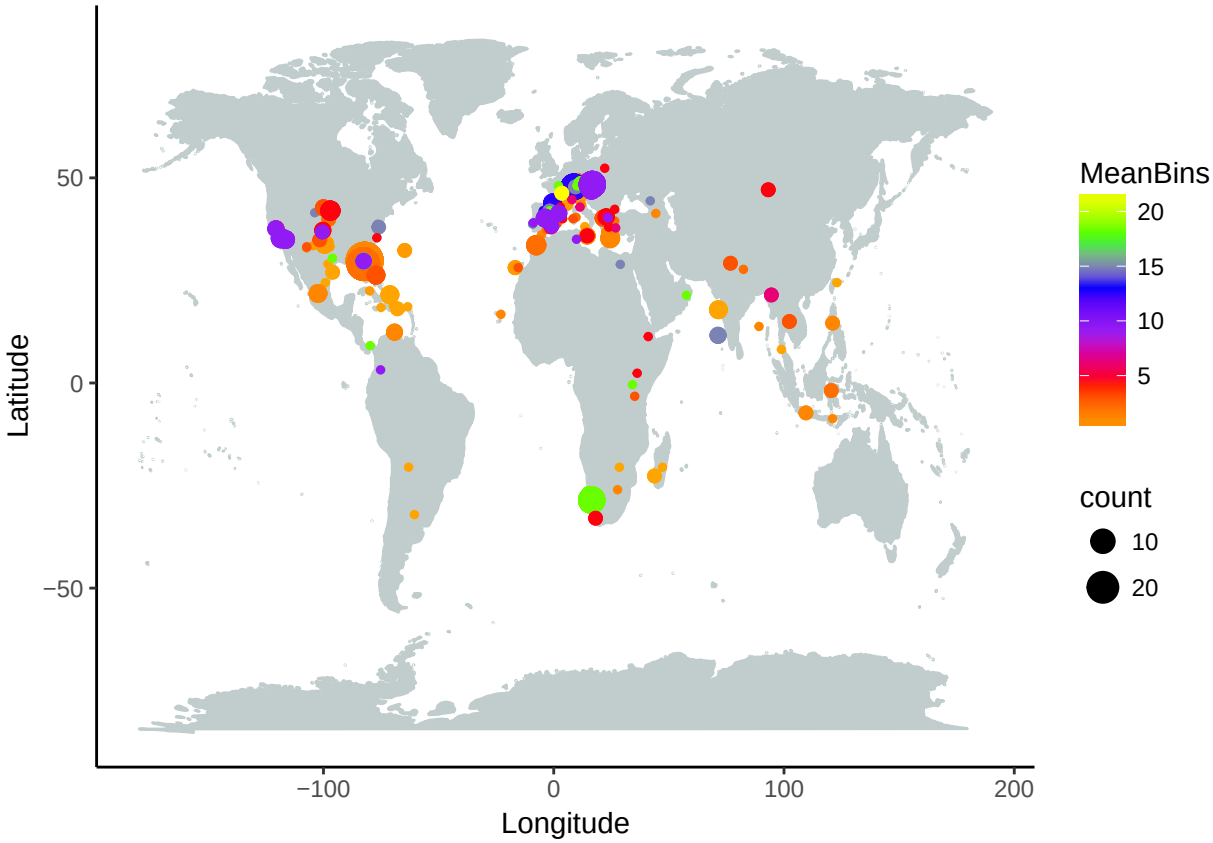
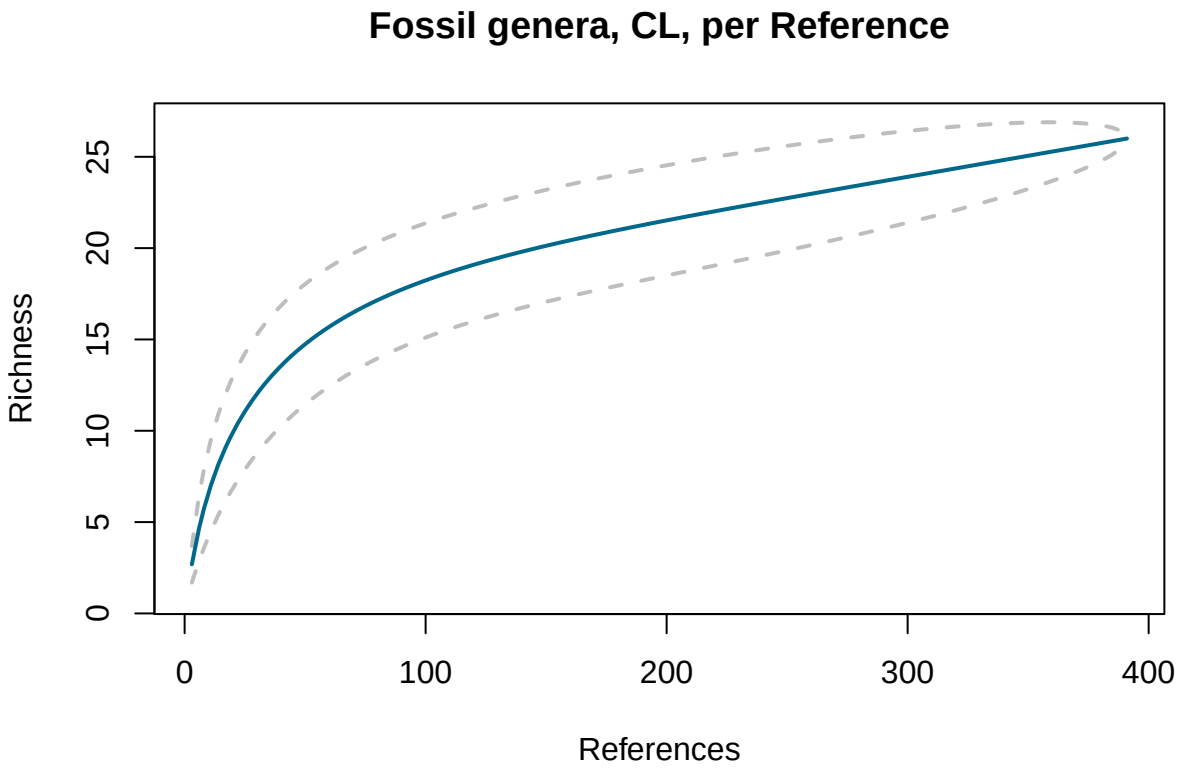


Figure 3: Map displaying all localities for which body size data for testudinids was available in the literature. Size of points denotes sample size, color denotes approximate age.

Sampling Accumulation Curve



Eurasia

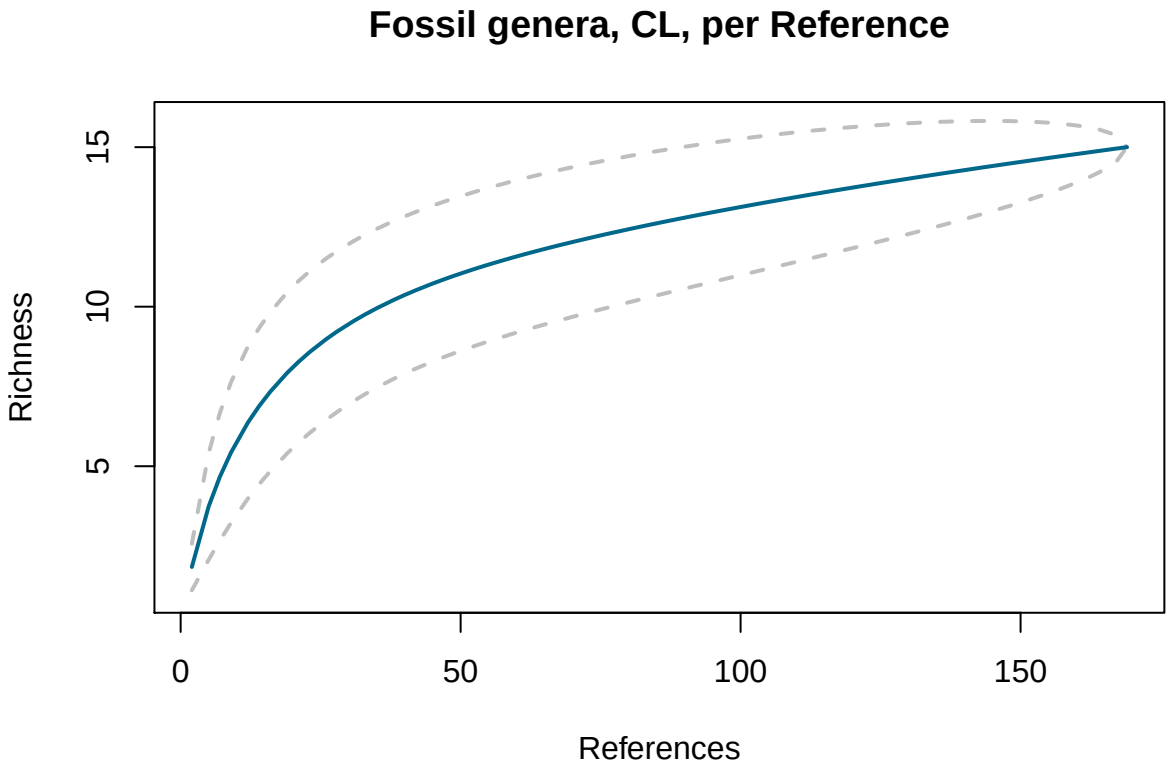


Figure 4: Sampling Accumulation Curve of fossil genera per reference, Eurasia

Histograms

all

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

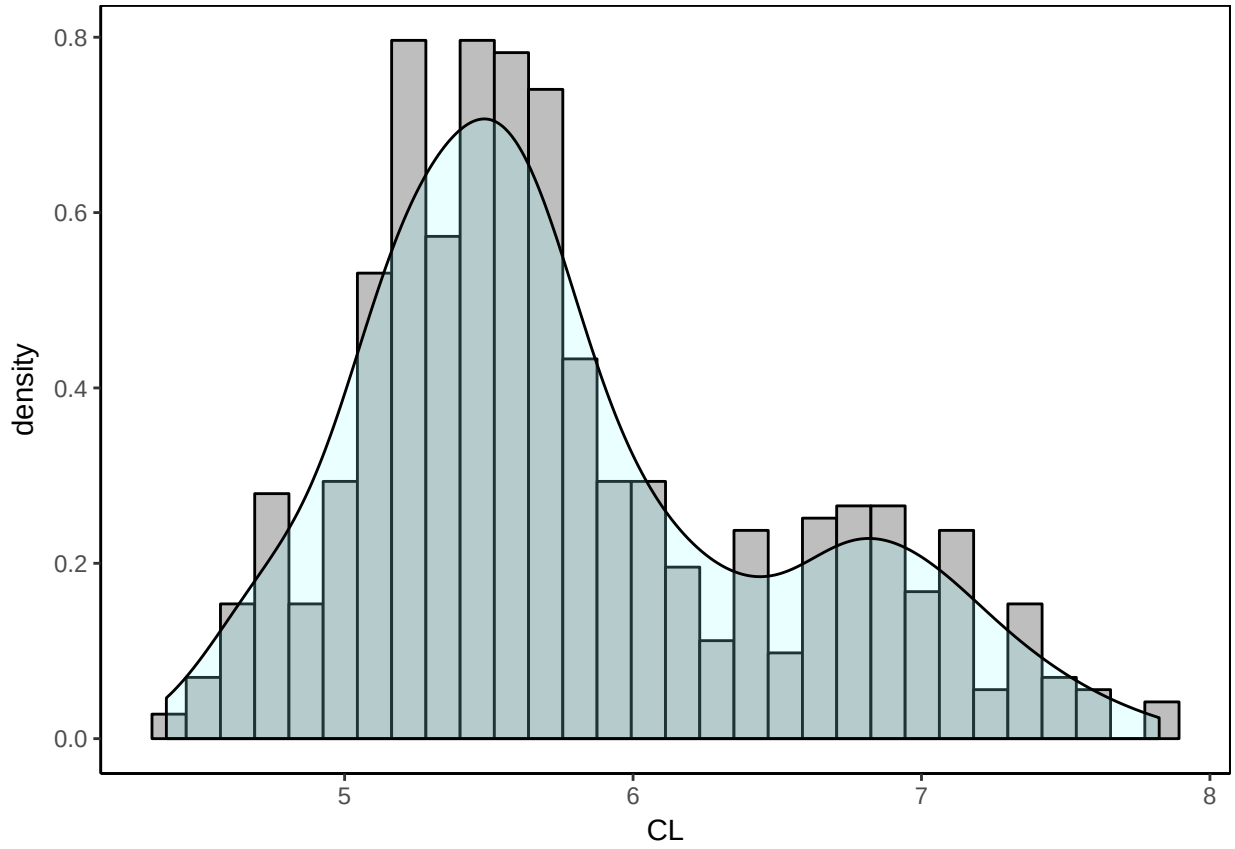
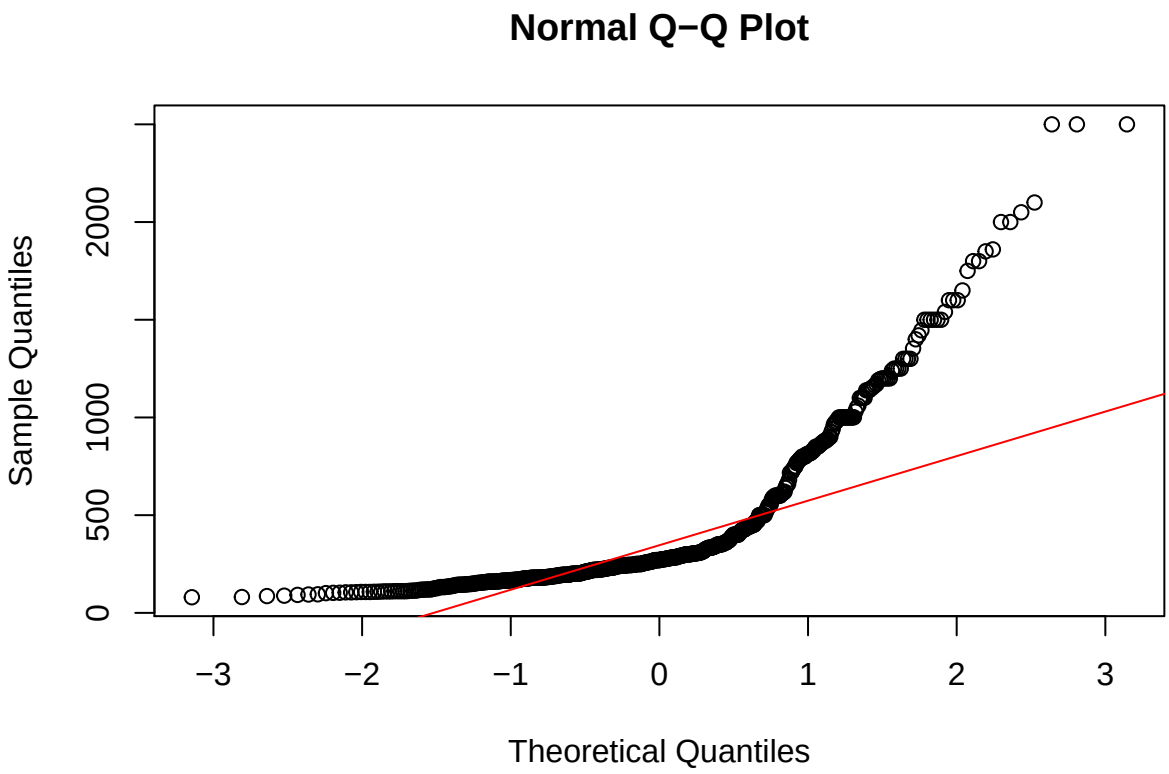
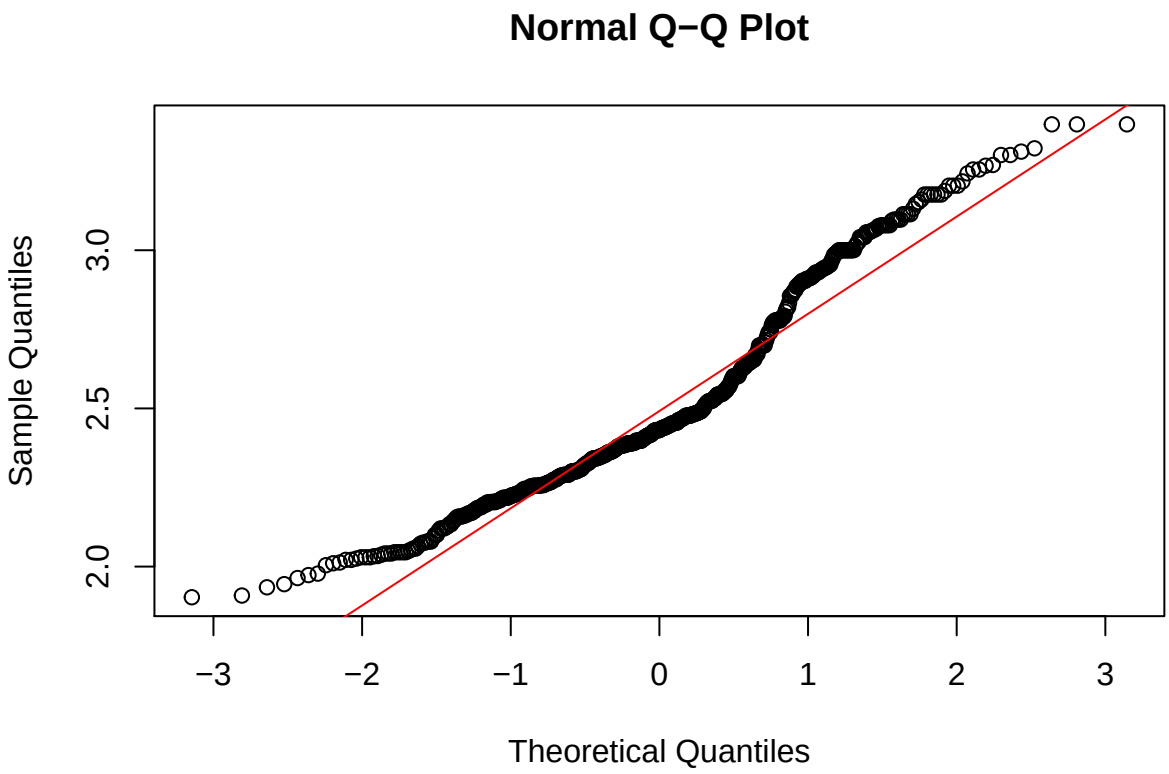


Figure 5: Distribution of body size data, logtransformed, all data.

```
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`.
```

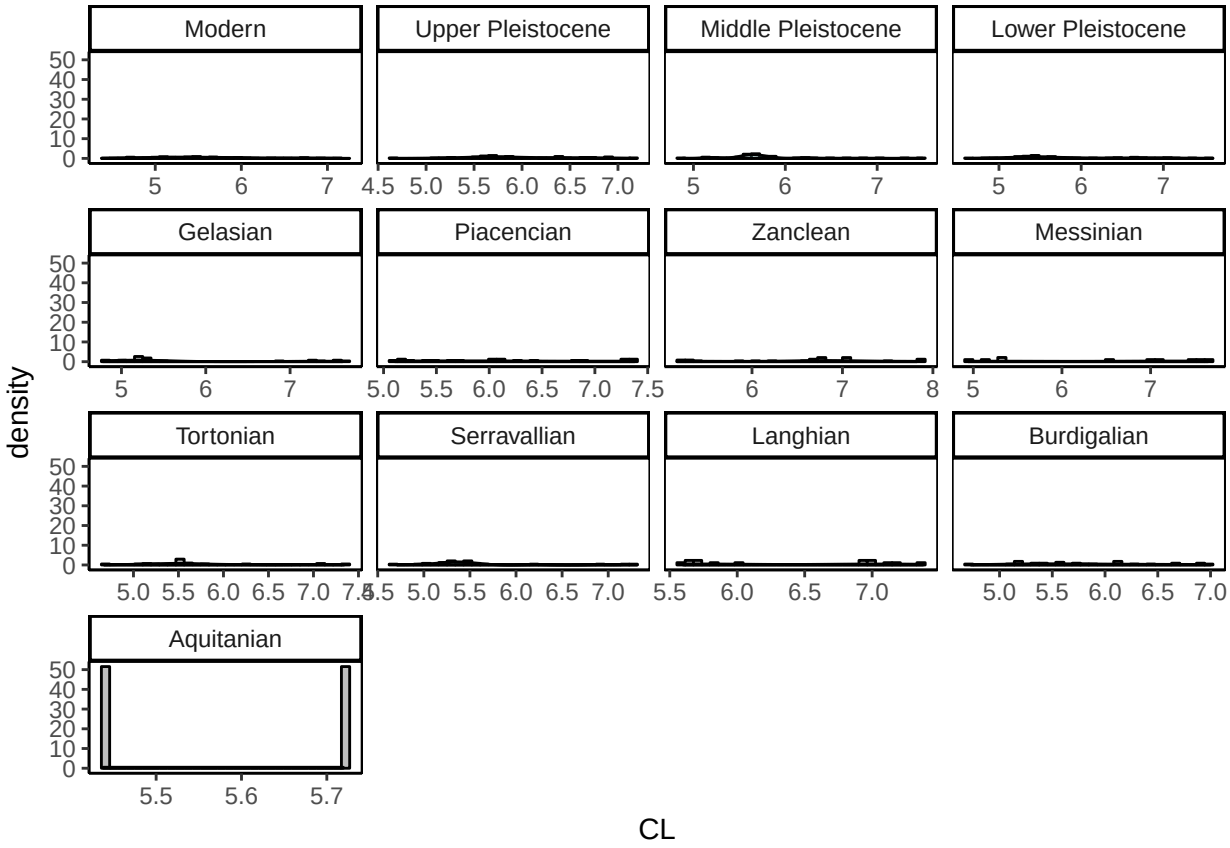


Figure 6: Distribution of body size data per time bin, logtransformed.

modern vs. fossil

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

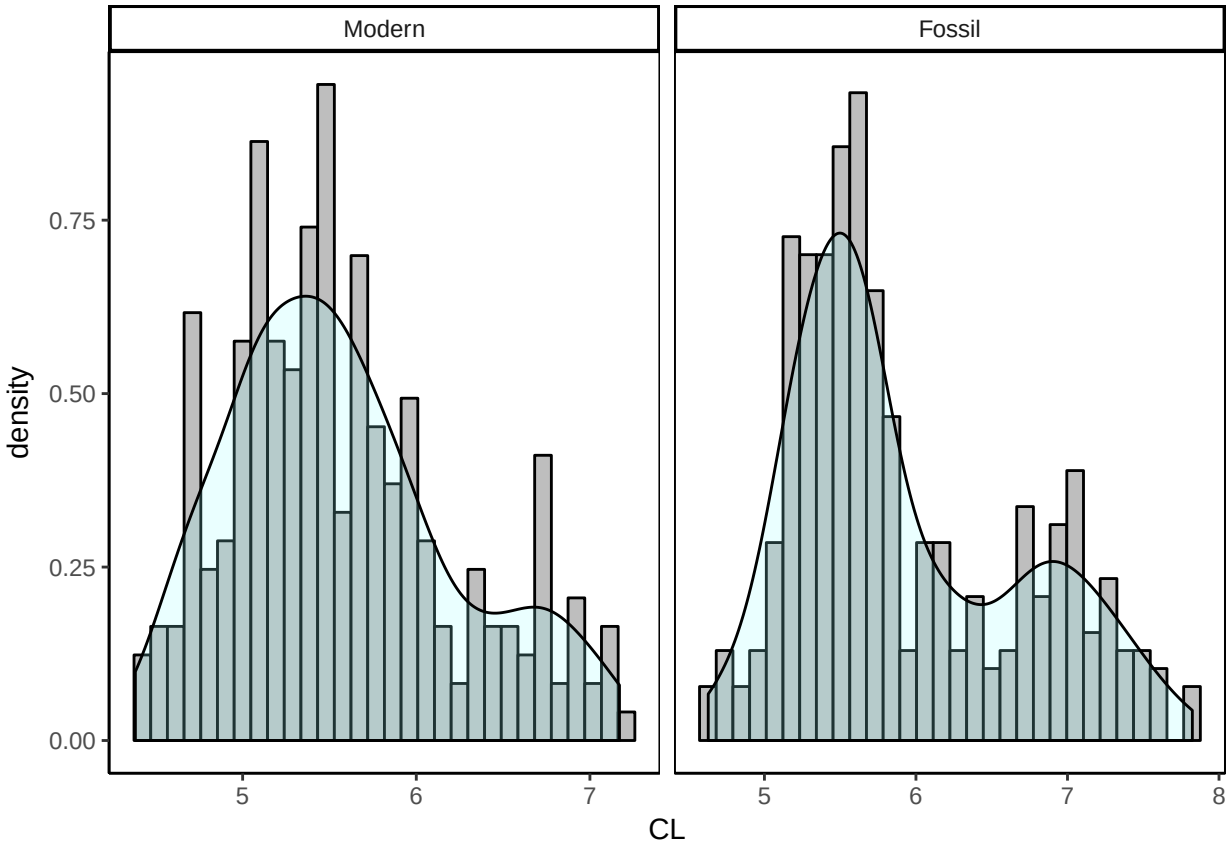


Figure 7: Distribution of body size data modern vs. fossil, logtransformed.

modern vs. fossil, continental vs. insular

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

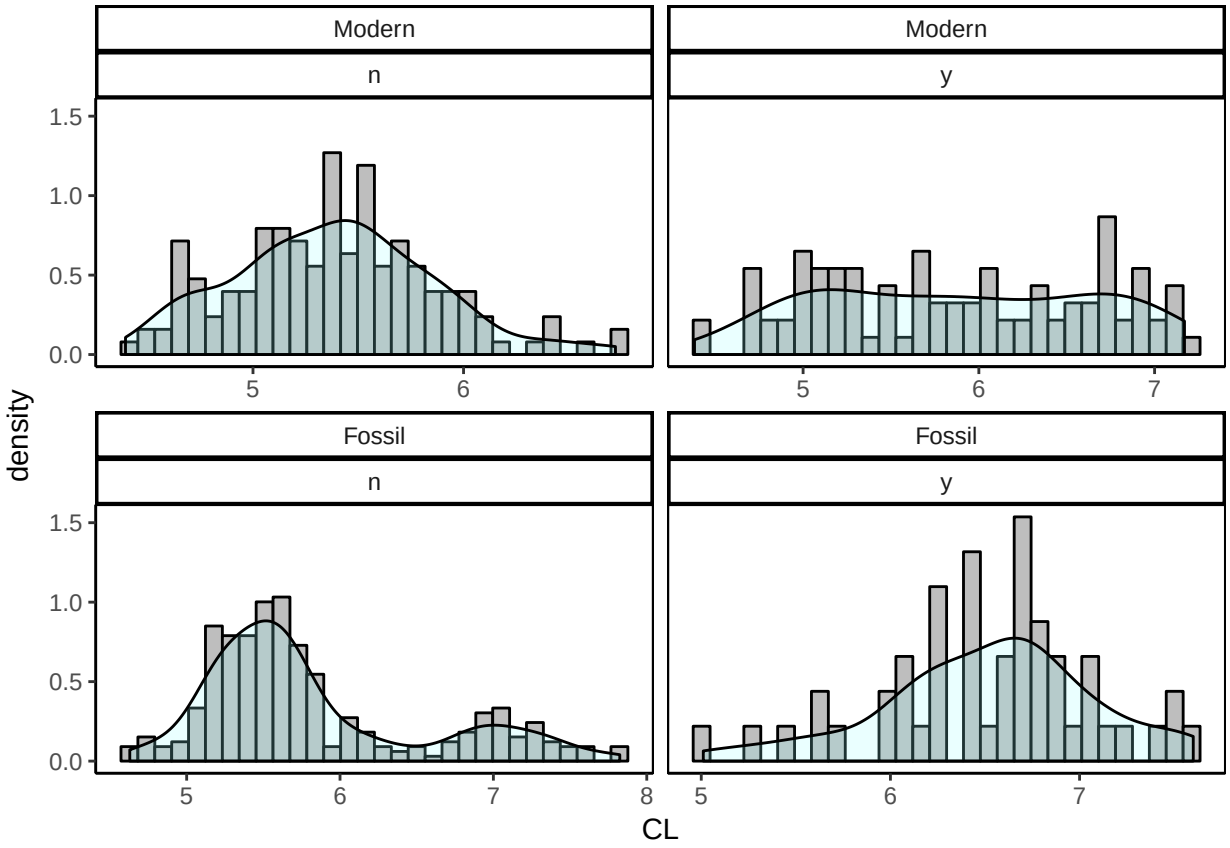


Figure 8: Distribution of body size data modern vs. fossil, continental vs. insular logtransformed.

continental vs. insular

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

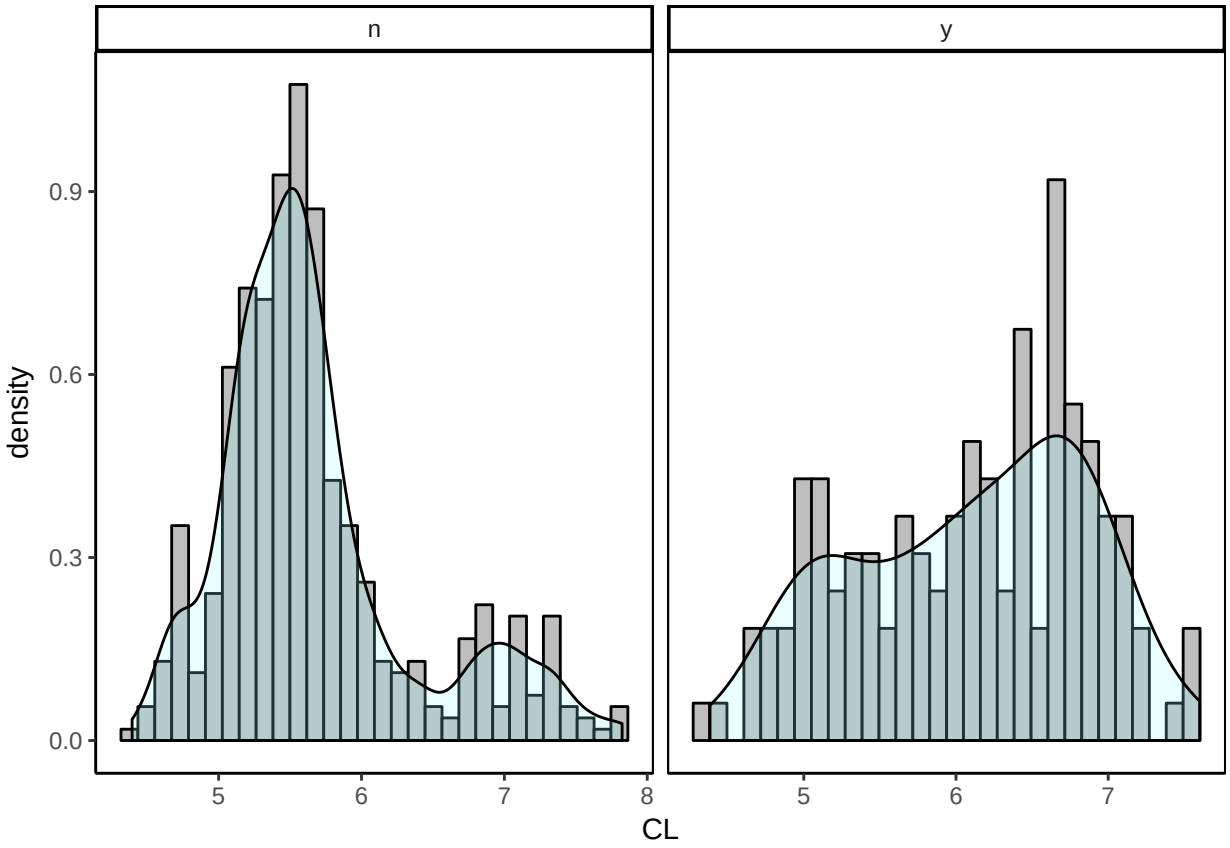


Figure 9: Distribution of body site data of continental (n) and insular(y) species, logtransformed.

continents

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

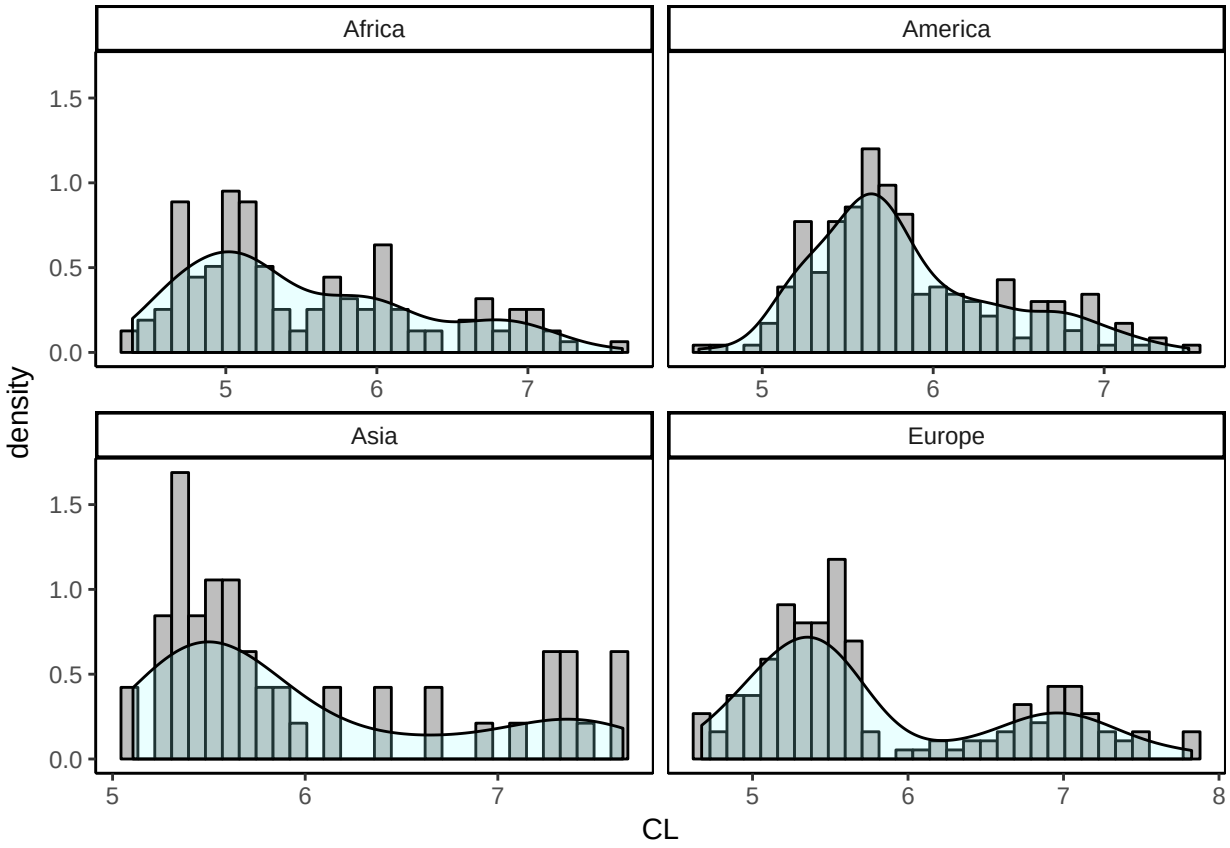


Figure 10: Distribution of body site data per continent, logtransformed.

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
603	80.00	2500.0	165301.024	435.9	2.5	270.0	2.4	2.17	0.71	8.11	2.77	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
47	102.44	1250.0	68679.401	441.9	2.6	334.7	2.5	1.26	0.24	3.85	2.66	Upper Pleistocene
52	132.00	1800.0	99827.711	387.4	2.5	292.5	2.5	3.00	1.52	12.00	5.49	Middle Pleistocene
53	107.80	2000.0	162580.002	451.1	2.5	259.5	2.4	1.88	0.81	6.27	2.59	Lower Pleistocene
27	118.90	2050.0	451139.148	554.2	2.5	193.3	2.3	1.32	1.06	2.99	2.33	Gelasian
20	165.00	1600.0	269797.712	636.6	2.7	440.5	2.6	0.96	0.29	2.38	1.78	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
44	107.00	1540.0	178032.415	468.4	2.5	250.0	2.4	1.46	0.78	3.63	2.48	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
350	102.44	2500.0	222502.054	512.1	2.6	285.4	2.5	1.84	0.72	6.12	2.45	Fossil
456	81.00	2500.0	158401.121	389.9	2.5	250.0	2.4	2.71	1.11	10.83	3.88	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
299	102.44	2500.0	215866.285	466.4	2.5	270.0	2.4	2.14	1.02	7.31	3.06	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
141	80.00	2050.0	112742.567	349.5	2.4	194.0	2.3	2.09	0.68	7.94	2.47	Africa
236	102.44	1800.0	80110.292	409.7	2.5	301.0	2.5	2.01	0.77	7.28	3.02	America
54	165.00	2100.0	342189.701	593.8	2.6	280.0	2.4	1.40	0.90	3.43	2.27	Asia

nCL	min	max	var	mean	logm	med	logmed	skew	logsk	kurt	logku	Variable
172	107.00	2500.0	255244.277	492.9	2.5	245.0	2.4	1.85	0.80	6.26	2.32	Europe

Boxplots

genera per time bins

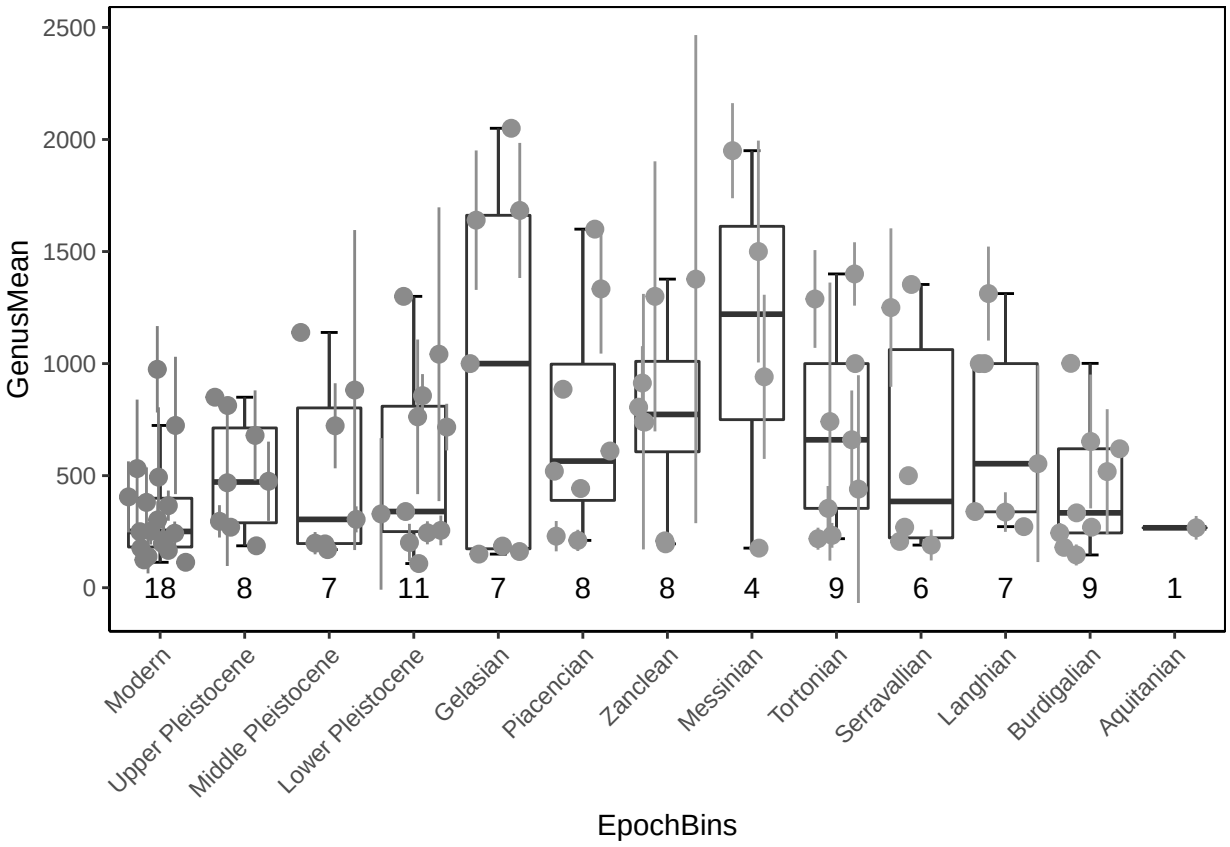


Figure 11: Boxplots of mean CL per time bin, including mean and sd CL for each genus (as pointrange).

continental vs. insular per time bin

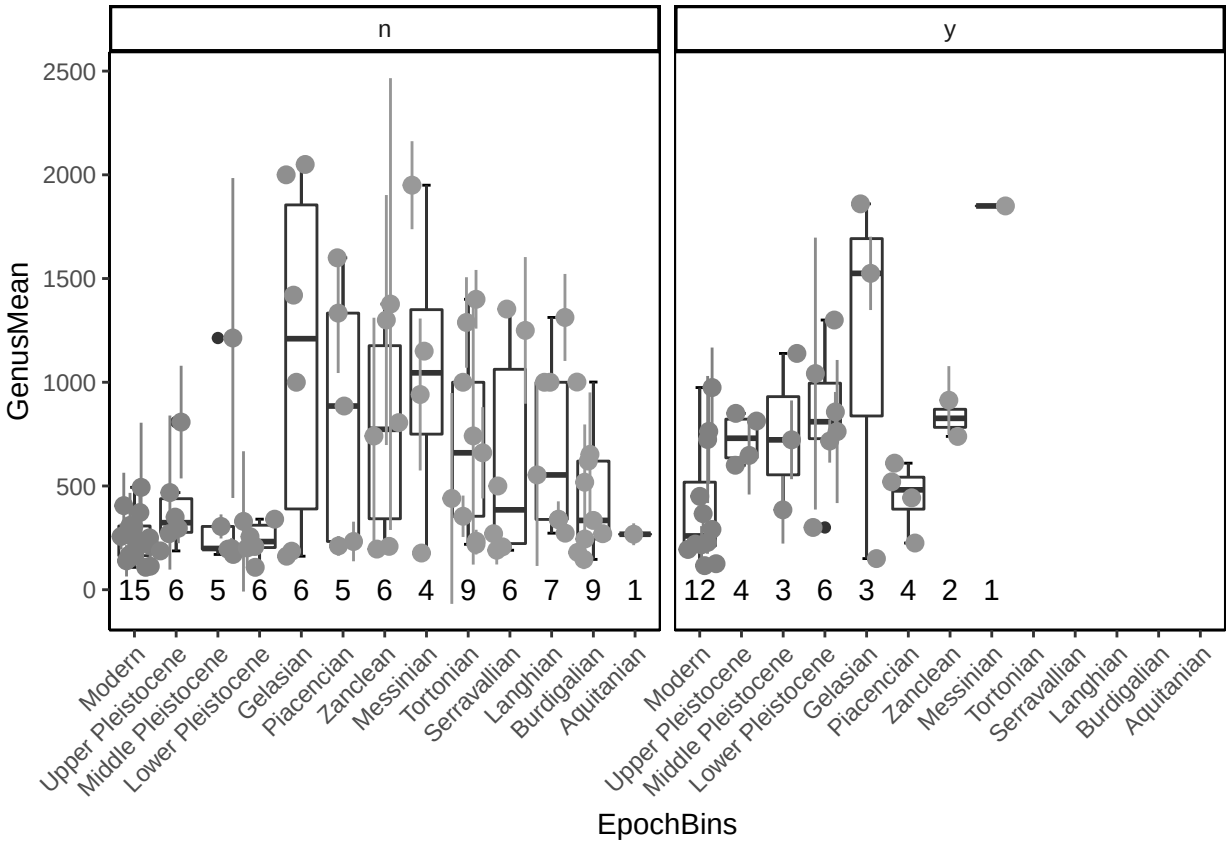


Figure 12: Boxplots of each genus per time bin, continental vs. insular species.

fossil vs. modern

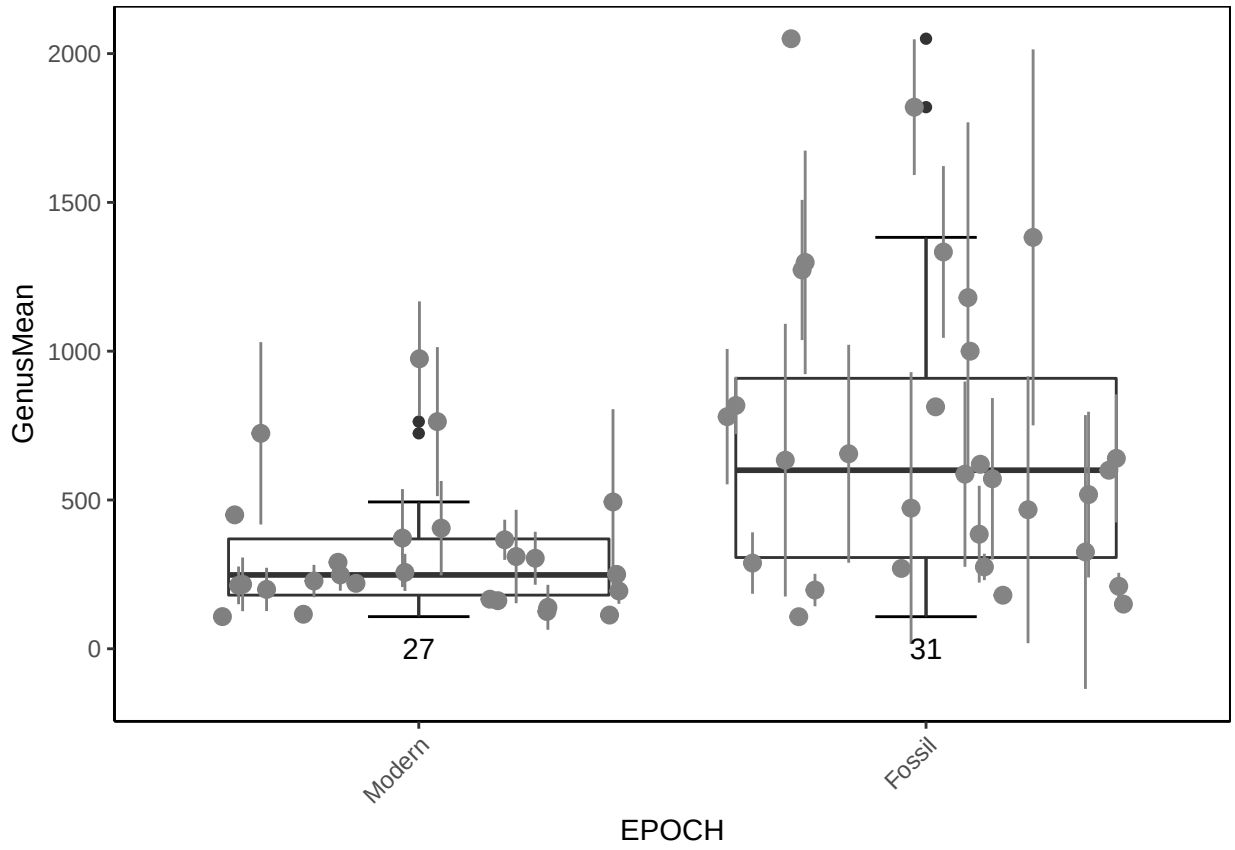
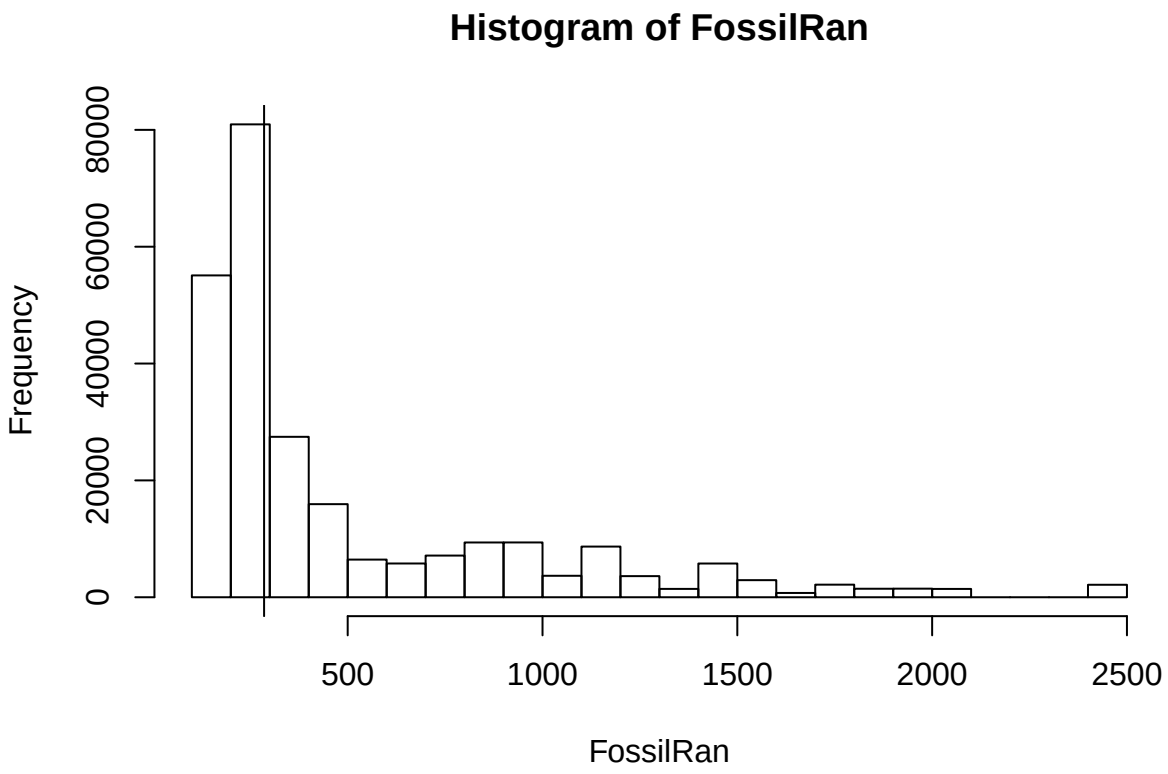


Figure 13: Boxplots fossil vs. modern.




```
## [1] 330.3495
```

```
## [1] 531.6337
```

```
##
```

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

```
##
```

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

```
## W = 22880, p-value = 2.877e-08
```

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

Wilcoxon Rank Sum Test (unpaired data):

modern $<$ fossil ($\mathrm{P} = 2.8767155 \times 10^{-8}$)

fossil vs. modern, continental vs. insular

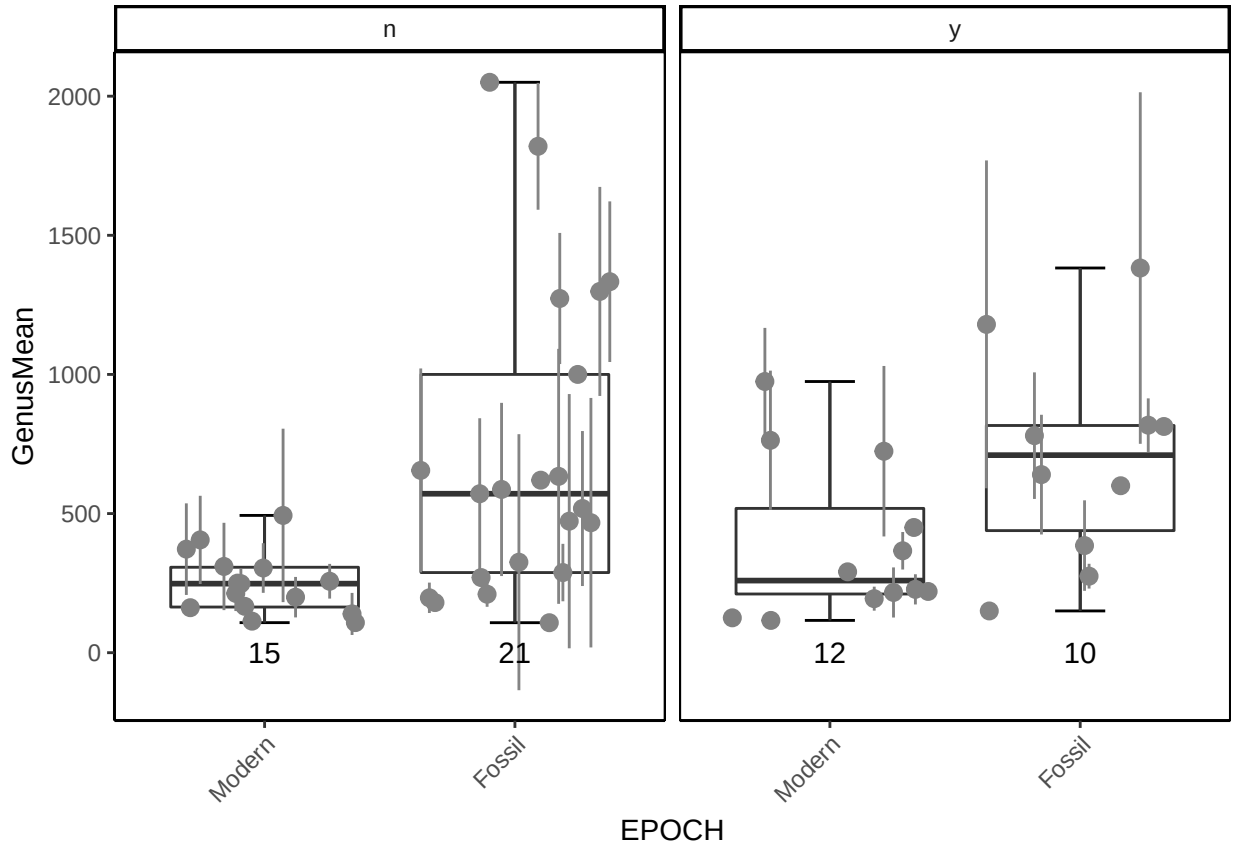


Figure 14: Boxplots fossil vs. modern, continental vs. insular species.

```
## [1] 51

## [1] 51

## [1] 779.9882

## [1] 514.1314

##
##  Wilcoxon rank sum test with continuity correction
##
## data:  ModernIsland and FossilIsland
## W = 810.5, p-value = 0.0005255
## alternative hypothesis: true location shift is less than 0

## [1] 157
```

```
## [1] 157
```

```
## [1] 244.0429
```

```
## [1] 473.7338
```

```
##
```

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

```
##
```

```
## data:  ModernCon and FossilCon
```

```
## W = 7977, p-value = 3.254e-08
```

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

Wilcoxon Rank Sum Test (unpaired data):

modern continental $<$ fossil continental ($\mathrm{P} = 3.254091 \times 10^{-8}$)

modern insular $<$ fossil insular ($\mathrm{P} = 5.2551691 \times 10^{-4}$)

continental vs. insular

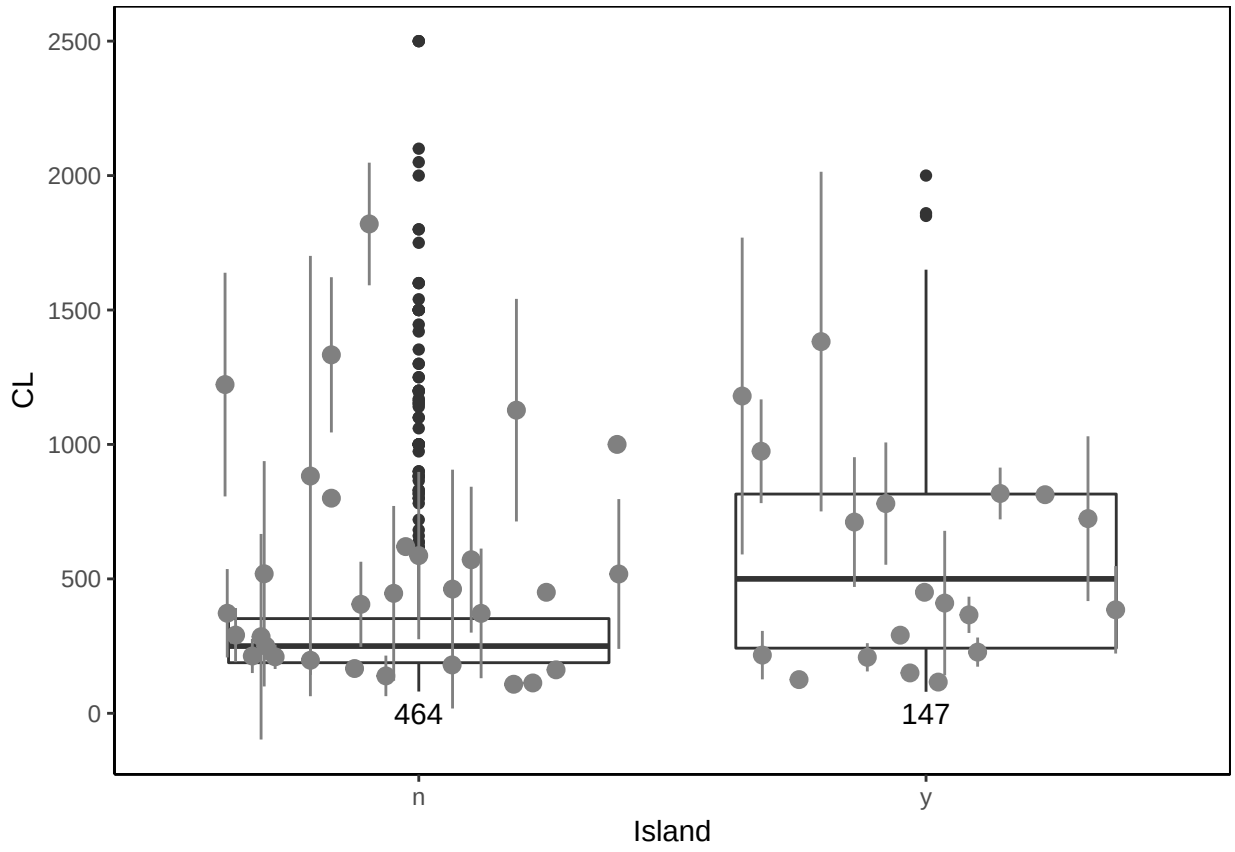


Figure 15: Boxplot continental vs. insular, genera summarised

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

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

```
## [1] 578.5245
```

```
## [1] 357.3304
```

```
##
```

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

```
##
```

```
## data:  Insular and Continental
```

```
## W = 14720, p-value = 3.902e-08
```

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

Wilcoxon Rank Sum Test (unpaired data):

continental < insular ($P = 3.9020068 \times 10^{-8}$)

continental vs. insular per time bin

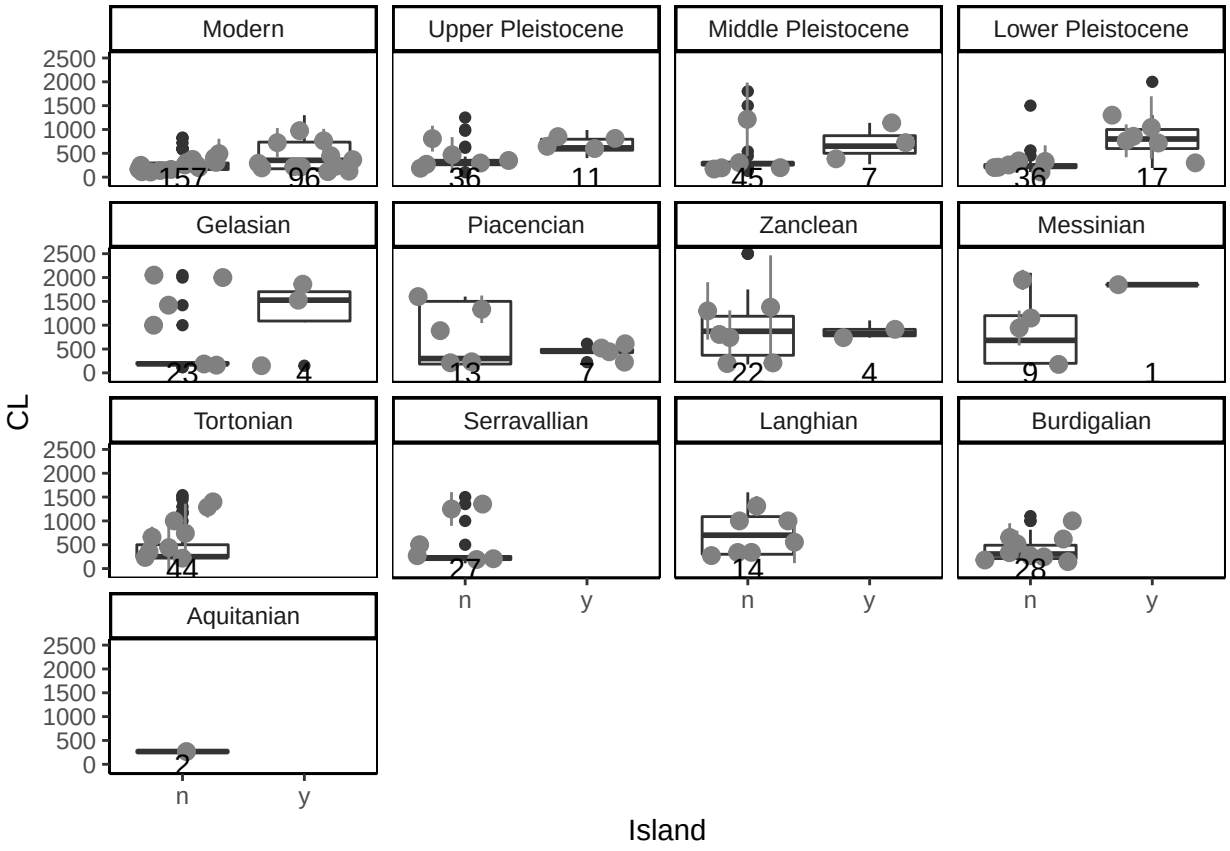


Figure 16: Boxplot continental vs. insular, genera summarised

continents

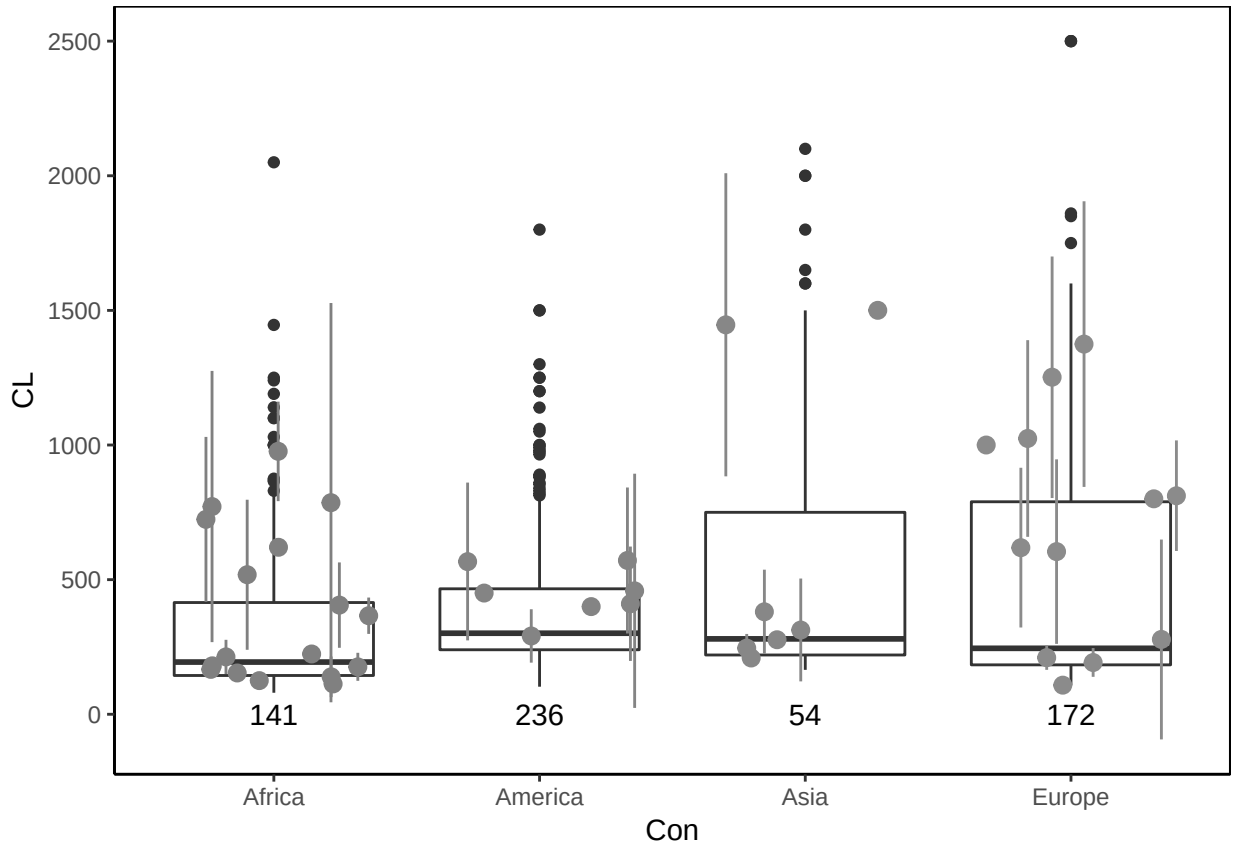


Figure 17: Boxplot: body size on different continents, genera summarised

```
## [1] 141

## [1] 349.5163

## [1] 141

## [1] 404.1091

## [1] 141

## [1] 445.4426

##
##  Kruskal-Wallis rank sum test
##
## data:  list(Africa, America, Eurasia)
## Kruskal-Wallis chi-squared = 21.797, df = 2, p-value = 1.849e-05
```

Wilcoxon Rank Sum Test (unpaired data):

Continent means differ ($P = 1.8487012 \times 10^{-5}$) (still have to look into the details...)

continents, continental vs. insular

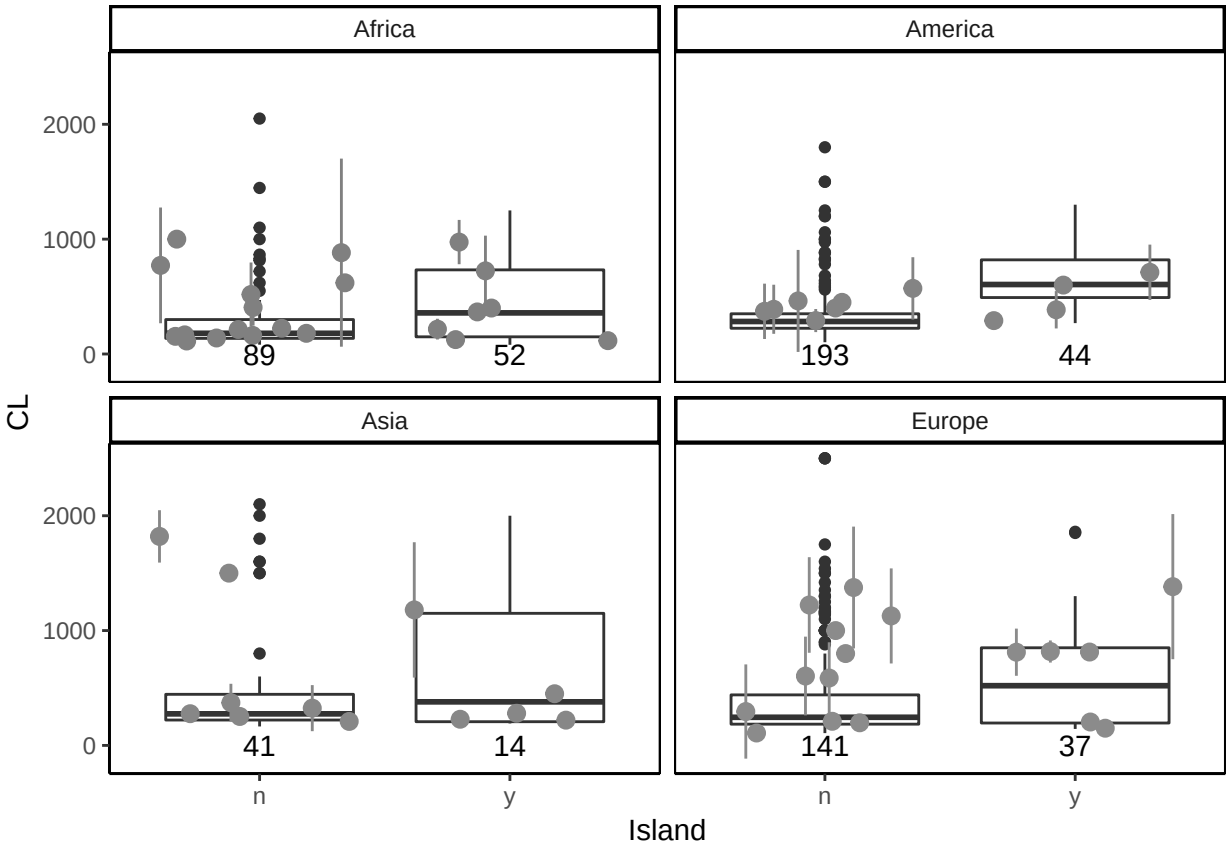


Figure 18: Boxplot: body size on different continents, genera summarised

paleoTS analysis

all (continental and insular)

genera (all)

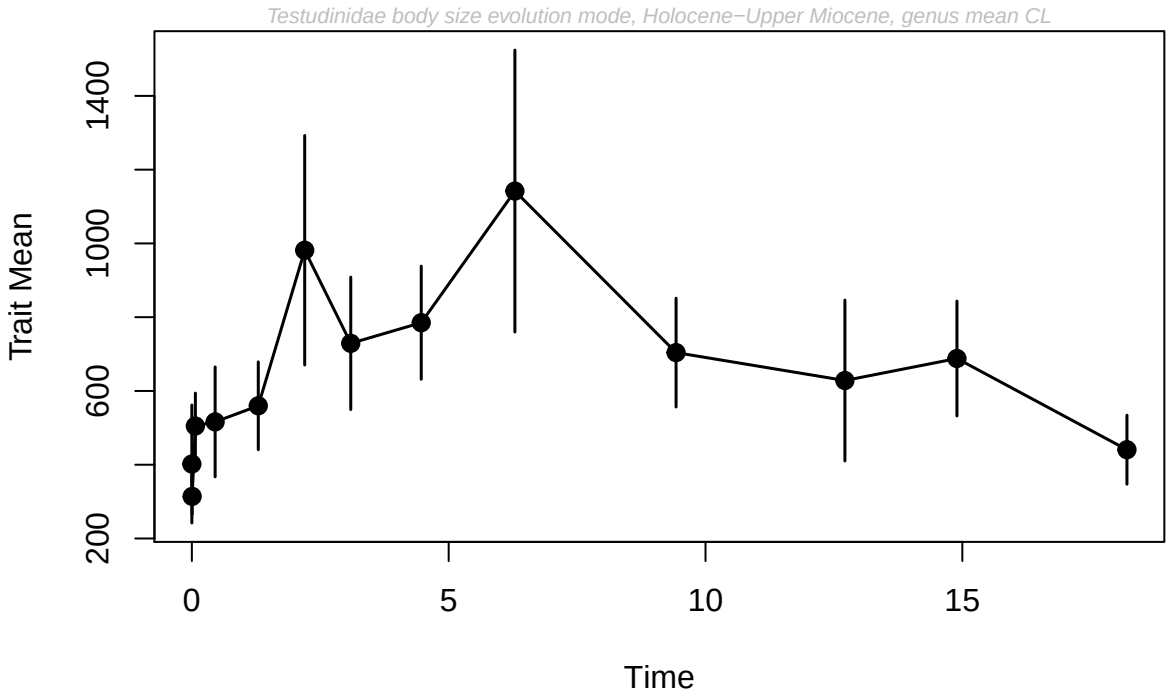


Figure 19: paleoTS plot with genus mean, including island species

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

	logL	K	AICc	Akaike.wt
GRW	-81.21073	2	167.7548	0.181
URW	-81.89172	1	166.1834	0.397
Stasis	-80.36094	2	166.0552	0.423

continental (excluding insular species)

genera (continental)

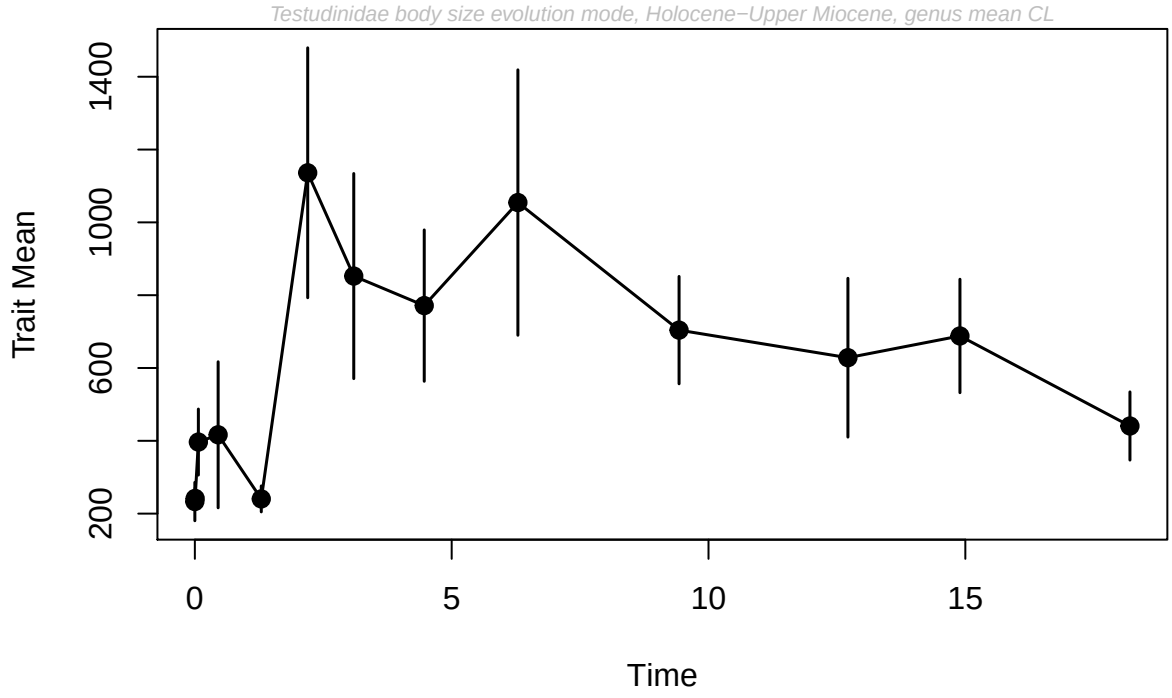


Figure 20: paleoTS plot with genus mean, excluding island species

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

	logL	K	AICc	Akaike.wt
GRW	-82.90379	2	171.1409	0.362
URW	-84.02953	1	170.4591	0.510
Stasis	-83.94656	2	173.2265	0.128

insular (excluding continental)

genera (insular)

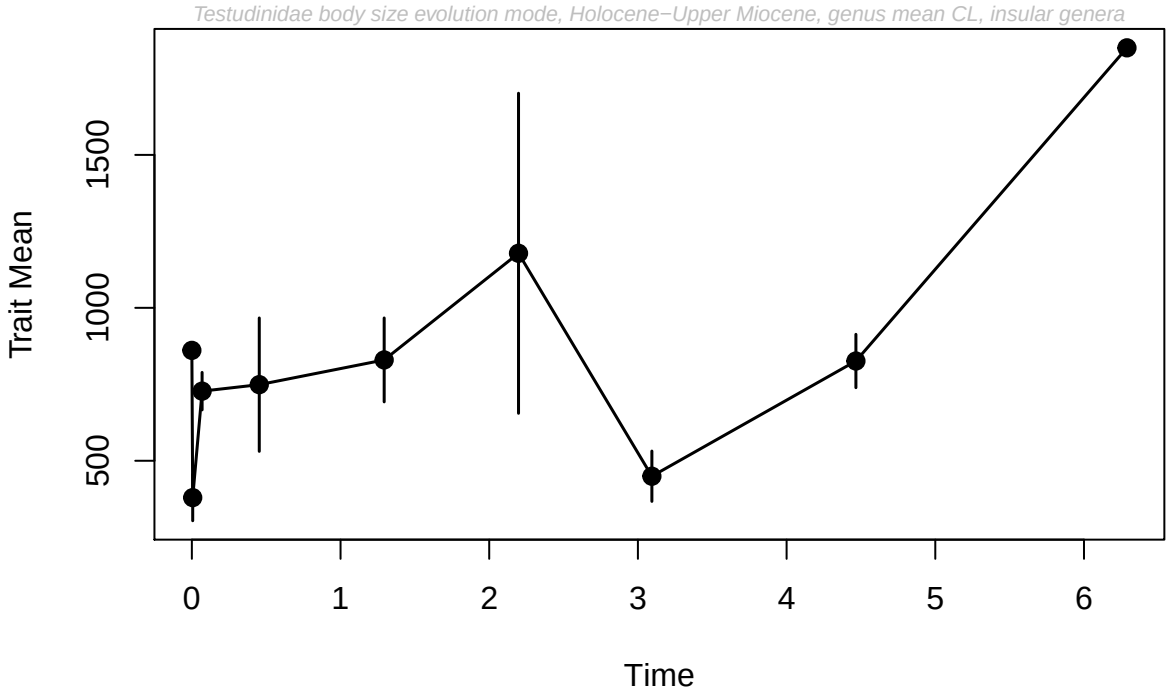


Figure 21: paleoTS plot with genus mean, only insular species

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

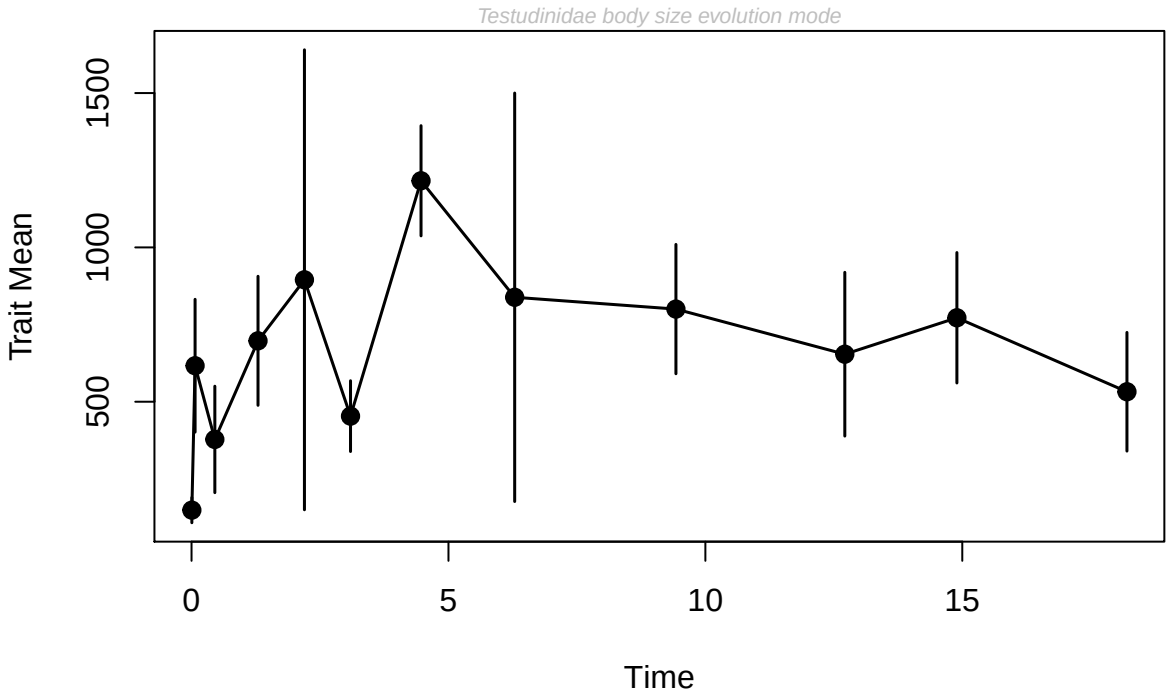


Figure 22: Smaller original bins, genera, Europe

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

	logL	K	AICc	Akaike.wt
GRW	-84.02267	2	173.5453	0.007
URW	-85.86954	1	174.1835	0.005
Stasis	-79.01974	2	163.5395	0.989

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

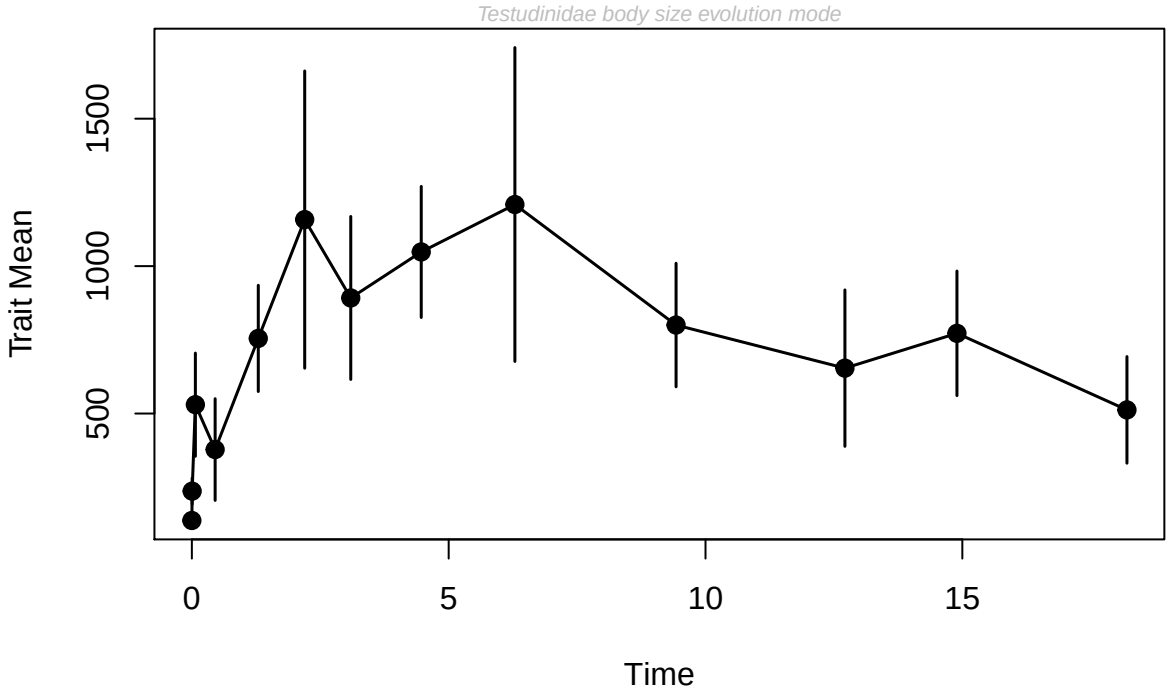


Figure 23: Smaller original bins, genera, Eurasia

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

	logL	K	AICc	Akaike.wt
GRW	-85.97735	2	177.2880	0.139
URW	-86.08942	1	174.5788	0.539
Stasis	-85.14103	2	175.6154	0.321