MAthesis

Contents

Time Bins with sample sizes

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

bin	EpochBins	MeanBins	nIndividuals	nSpecies	nGenera
(0,0.0117]	Modern	0.00585	252	64	18
(0.0117,0.126]	Upper Pleistocene	0.06885	47	16	8
(0.126,0.781]	Middle Pleistocene	0.45350	48	11	6
(0.781,2.59]	Lower Pleistocene	1.68450	73	27	11
(2.59,3.6]	Upper Pliocene	3.09400	23	15	9
(3.6,5.33]	Lower Pliocene	4.46600	29	17	8
(5.33,11.6]	Upper Miocene	8.47000	52	23	9
(11.6,16]	Middle Miocene	13.78900	38	17	11
(16,23]	Lower Miocene	19.50000	25	13	9
(23,50]	Oligocene and Eocene	36.51500	7	5	5

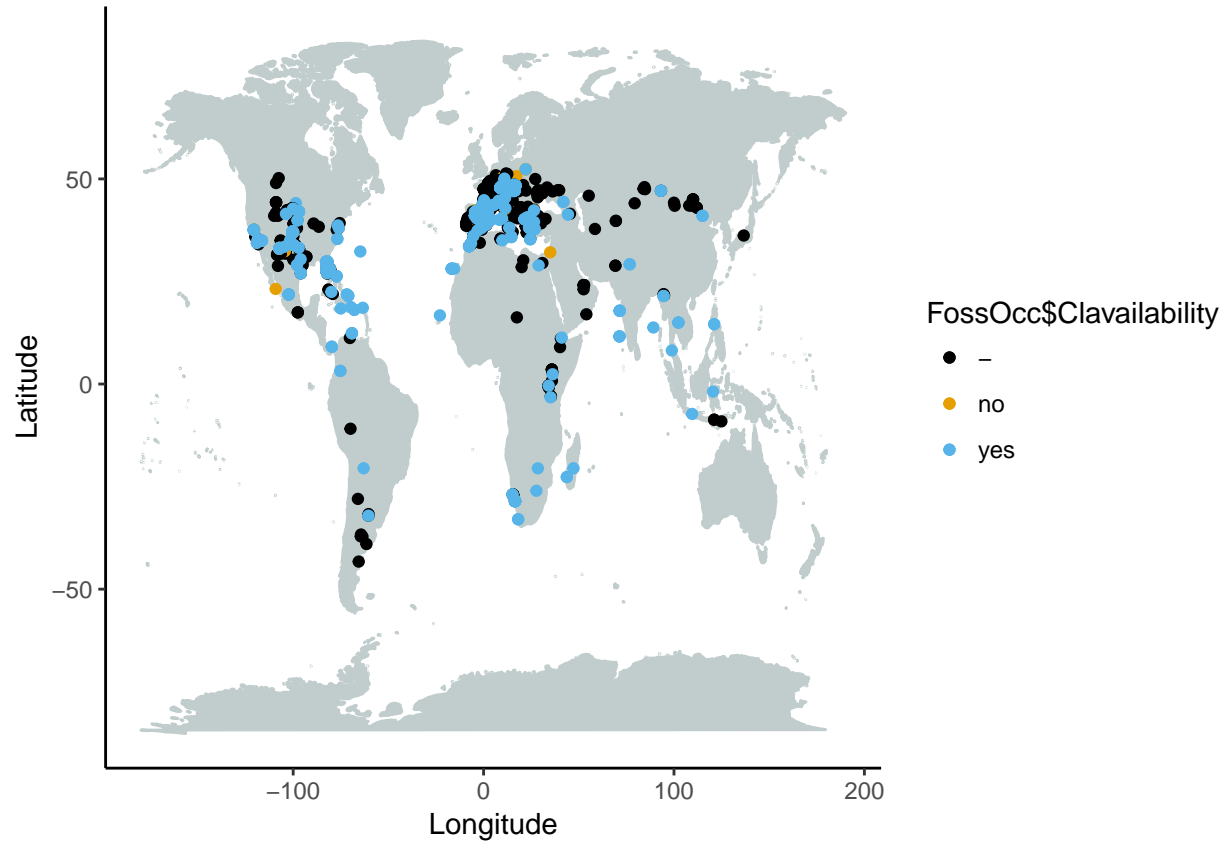# Maps

fossil occurences of testudinidae

Figure 1: 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
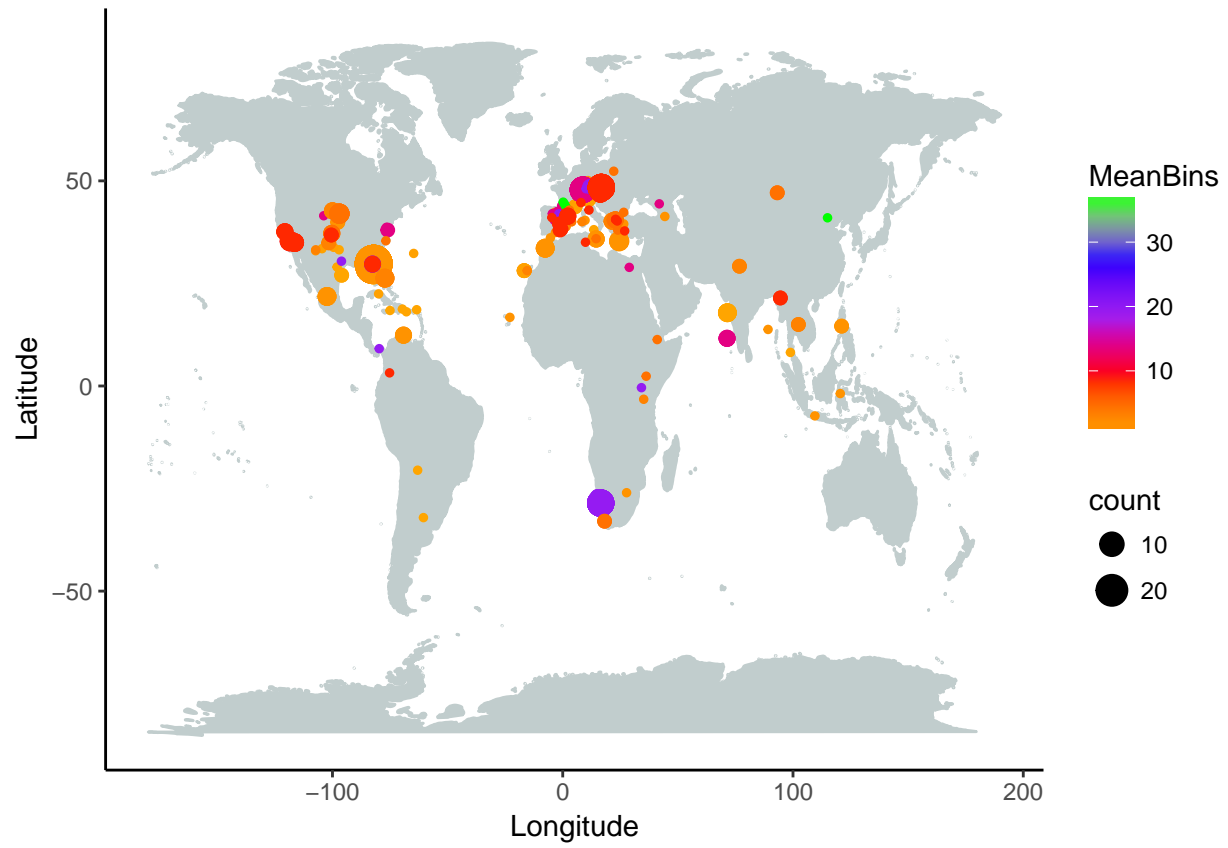
Figure 2: Map displaying all localities for which body size data for testudinids was available in the literature. Size of points denotes sample size, color denotes approximate age.

Sampling Accumulation Curve

Fossil genera, CL, per Reference
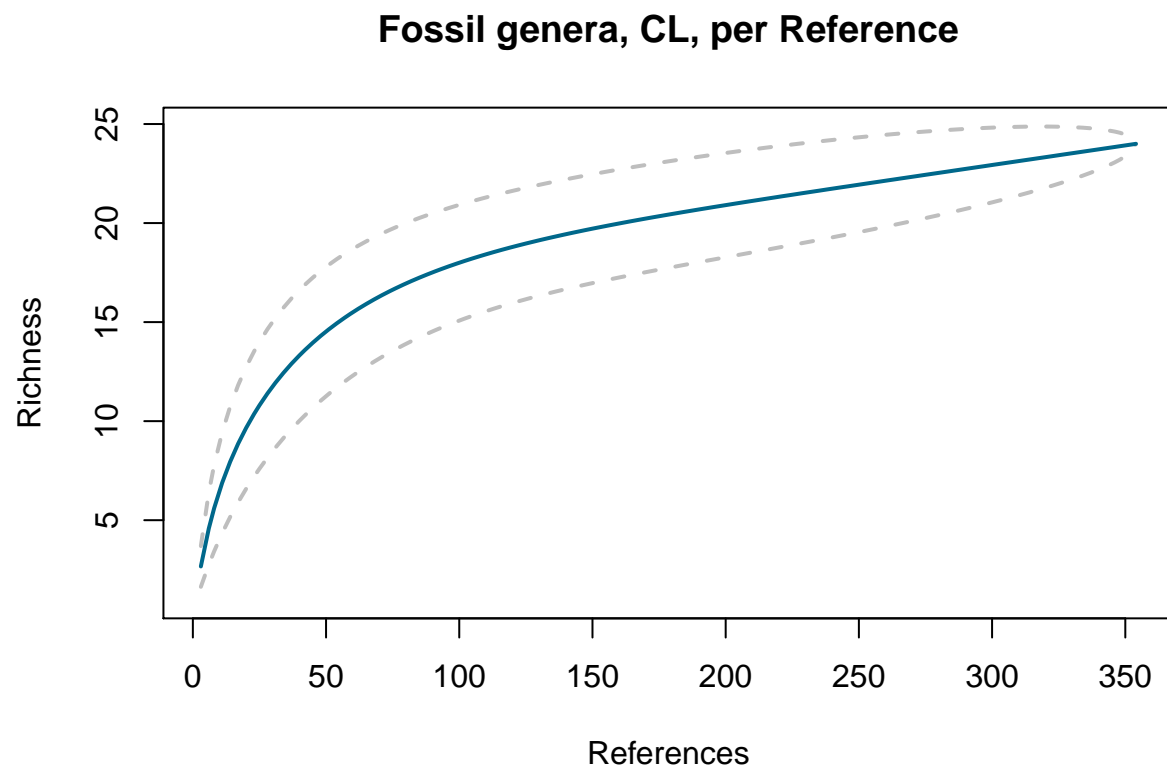
Figure 3: Sampling Accumulation Curve of fossil genera per reference

Histograms

all

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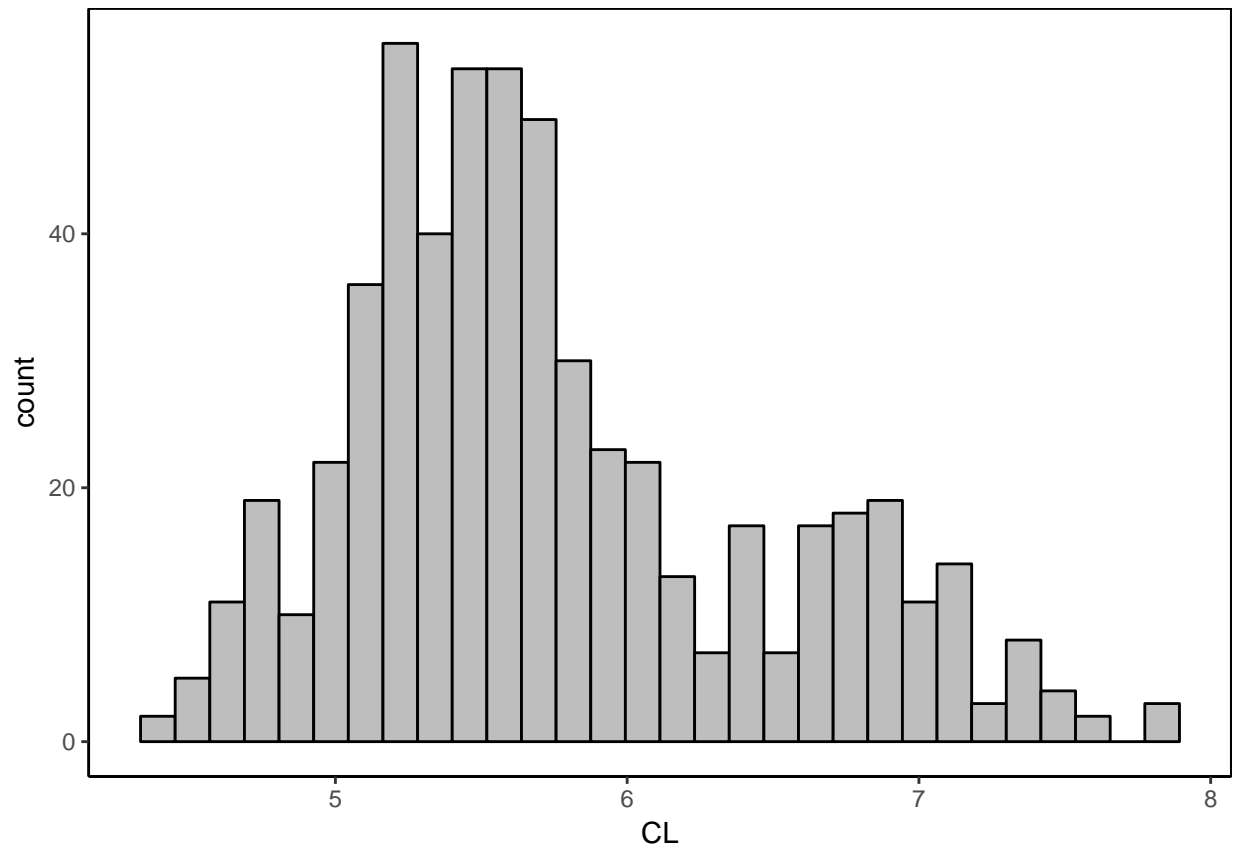

Figure 4: Distribution of body size data, logtransformed, all data.

per time bin

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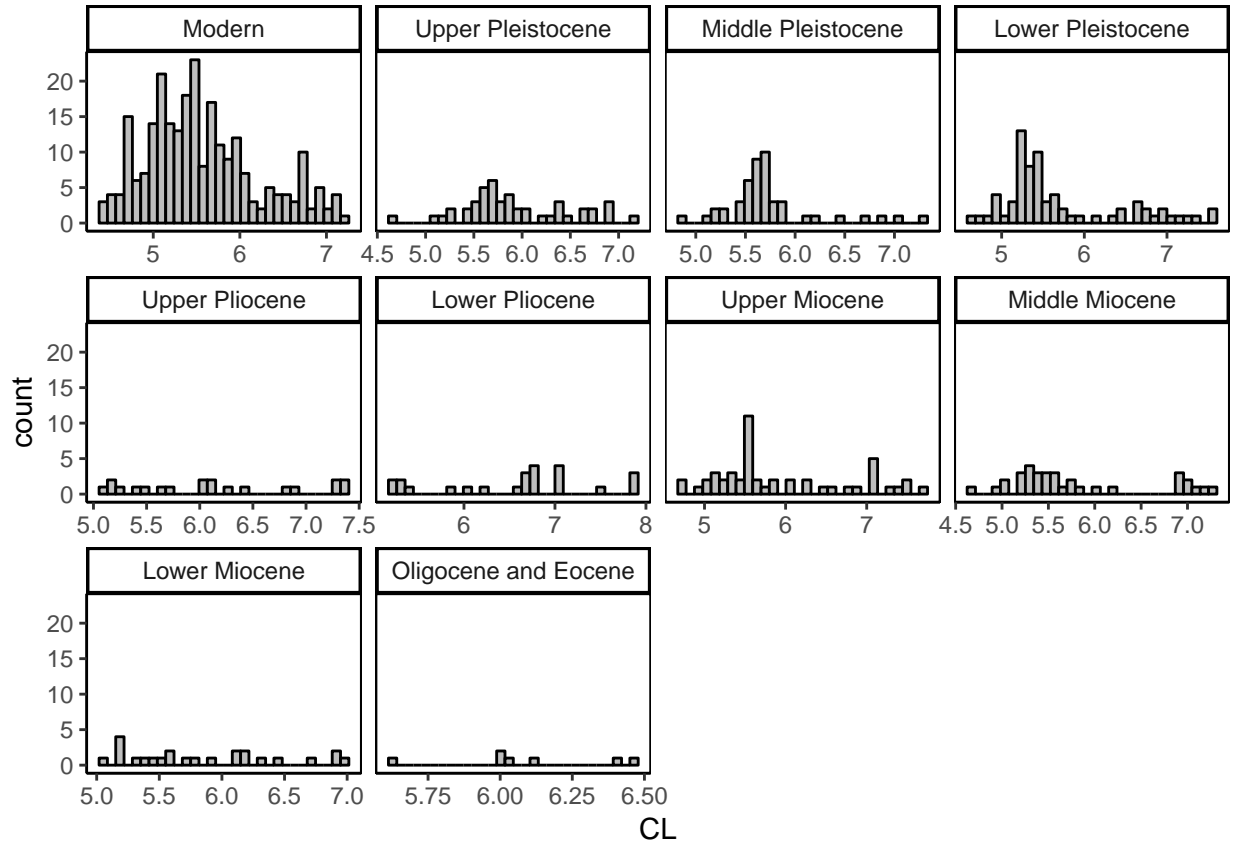

Figure 5: Distribution of body size data per time bin, logtransformed.

modern vs. fossil

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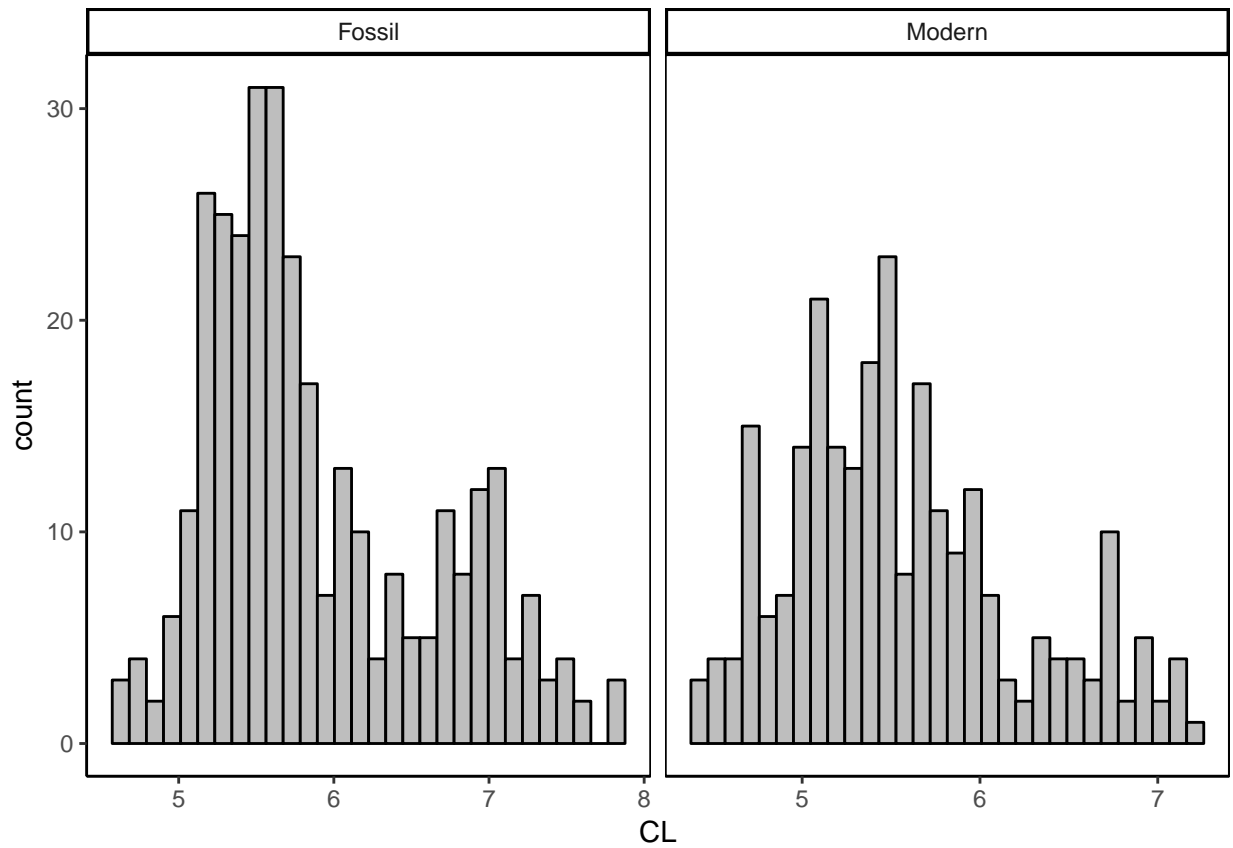

Figure 6: Distribution of body size data modern vs. fossil, logtransformed.

modern vs. fossil, continental vs. insular

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


Figure 7: 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 8: Distribution of body site data of continental (n) and insular(y) species, logtransformed.

continents

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


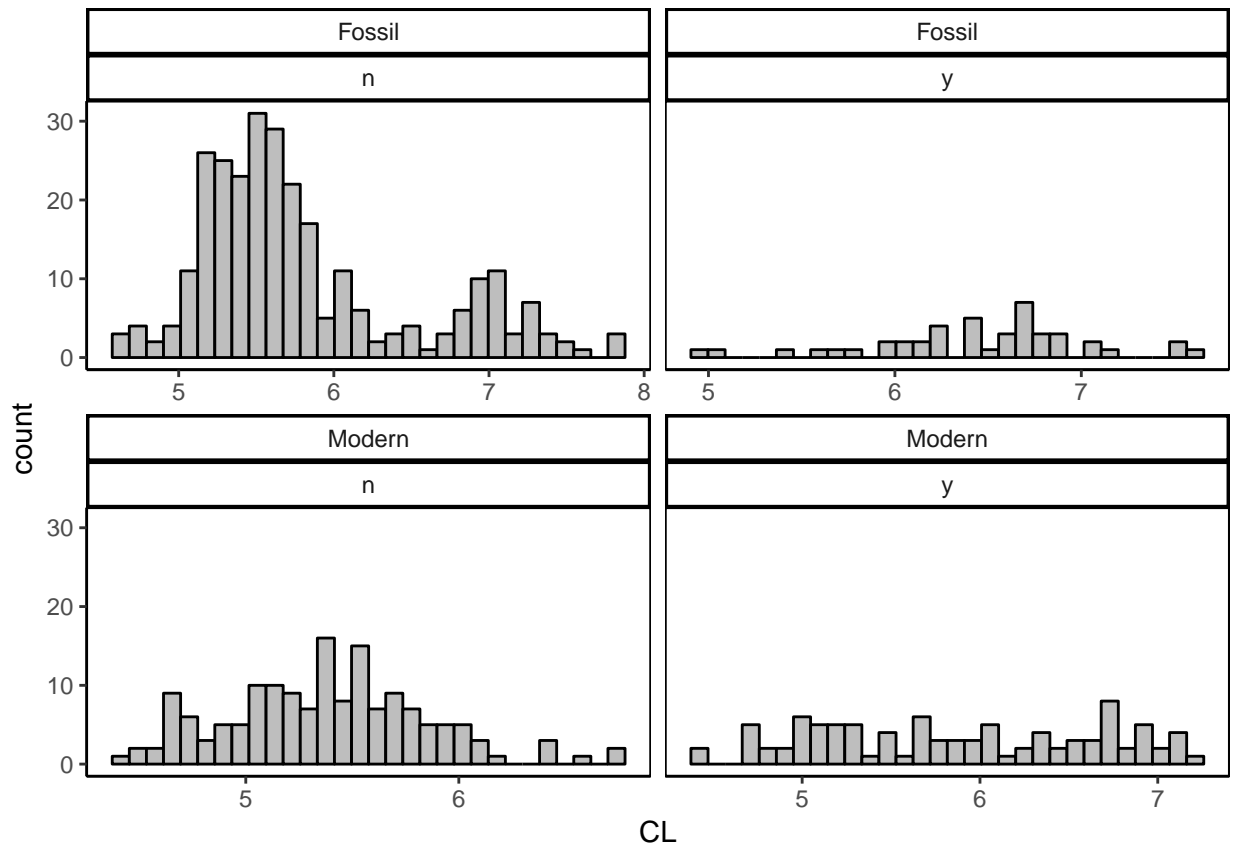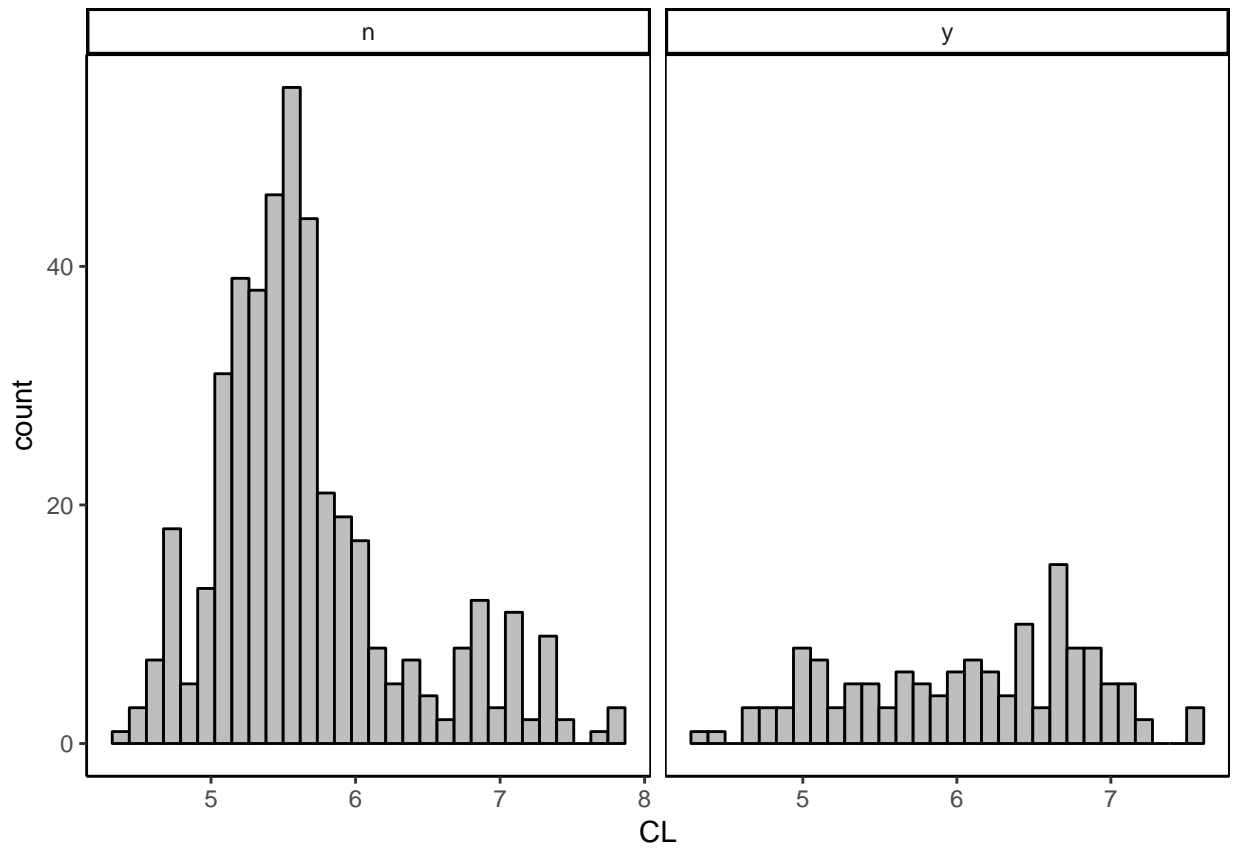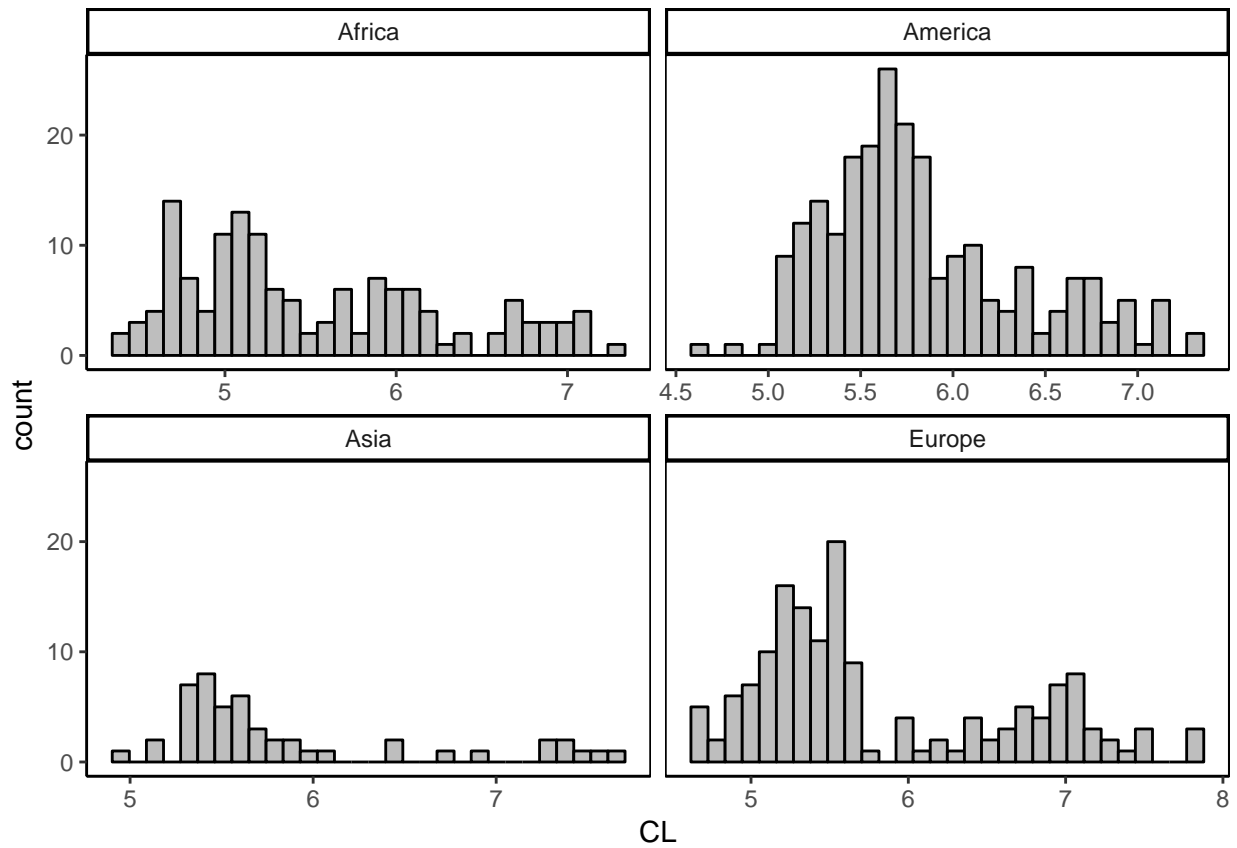Figure 9: Distribution of body site data per continent, logtransformed.

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
573	80.00	2500	146793.95	419.2	2.5	270.0	2.4	2.30	0.70	9.25	2.84	all
251	80.00	1300	67716.64	328.9	2.4	242.0	2.4	1.85	0.60	5.91	2.73	Modern
46	102.44	1250	69637.75	438.4	2.6	331.1	2.5	1.30	0.29	3.89	2.69	Upper Pleistocene
47	132.00	1500	64523.61	357.3	2.5	285.6	2.5	2.99	1.58	12.00	5.93	Middle Pleistocene
71	107.80	2000	176257.96	417.4	2.5	224.1	2.4	2.08	1.06	6.77	2.99	Lower Pleistocene
20	165.00	1600	269797.71	636.6	2.7	440.5	2.6	0.96	0.29	2.38	1.78	Upper Pliocene
24	176.00	2500	516172.48	953.5	2.8	847.5	2.9	1.08	-0.31	3.32	2.13	Lower Pliocene
49	107.00	2100	274774.35	542.8	2.6	250.0	2.4	1.46	0.66	4.00	2.17	Upper Miocene
34	111.00	1500	169511.65	454.8	2.5	255.0	2.4	1.32	0.83	3.16	2.29	Middle Miocene
24	160.00	1100	81679.97	425.8	2.5	317.0	2.5	1.20	0.48	3.25	2.06	Lower Miocene
7	275.00	635	15613.99	453.2	2.6	412.5	2.6	0.29	-0.17	2.06	2.36	Oligocene and Eocene
322	102.44	2500	197478.39	489.7	2.6	287.8	2.5	2.03	0.74	7.31	2.60	Fossil
251	80.00	1300	67716.64	328.9	2.4	242.0	2.4	1.85	0.60	5.91	2.73	Modern
434	81.00	2500	137816.81	375.5	2.5	250.0	2.4	2.90	1.08	12.62	3.97	continental
139	80.00	2000	151260.27	555.7	2.6	466.0	2.7	1.08	-0.24	4.33	2.01	insular
278	102.44	2500	190561.55	450.5	2.5	272.5	2.4	2.30	1.02	8.54	3.17	fossil-con
44	140.00	2000	174122.42	737.0	2.8	694.5	2.8	1.34	-0.48	4.99	3.50	fossil-ins
156	81.00	830	16385.92	241.9	2.3	220.5	2.3	1.97	0.29	8.59	3.02	modern-con
95	80.00	1300	119898.26	471.7	2.6	351.0	2.5	0.82	0.02	2.44	1.75	modern-ins
140	80.00	1446	92601.87	337.4	2.4	193.5	2.3	1.69	0.64	5.04	2.35	Africa
230	102.44	1500	73060.64	402.7	2.5	300.0	2.5	1.85	0.77	6.10	2.97	America
49	140.00	2100	286030.39	505.9	2.6	275.0	2.4	1.87	1.28	5.03	3.29	Asia
154	107.00	2500	251479.46	490.8	2.5	245.0	2.4	1.95	0.77	6.86	2.32	Europe

Boxplots

genera per time bins
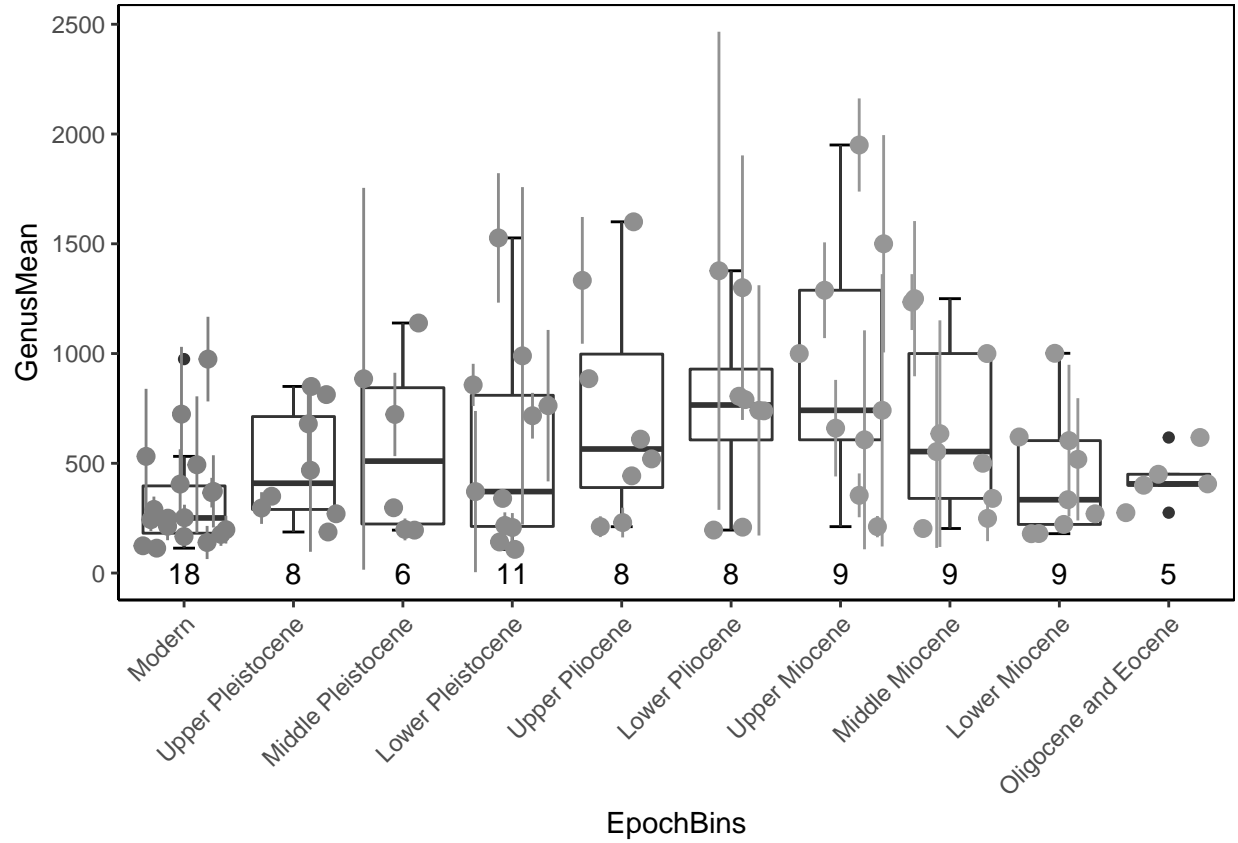
Figure 10: Boxplots of mean CL per time bin, including mean and sd CL for each genus (as pointrange).

continental vs. insular per time bin
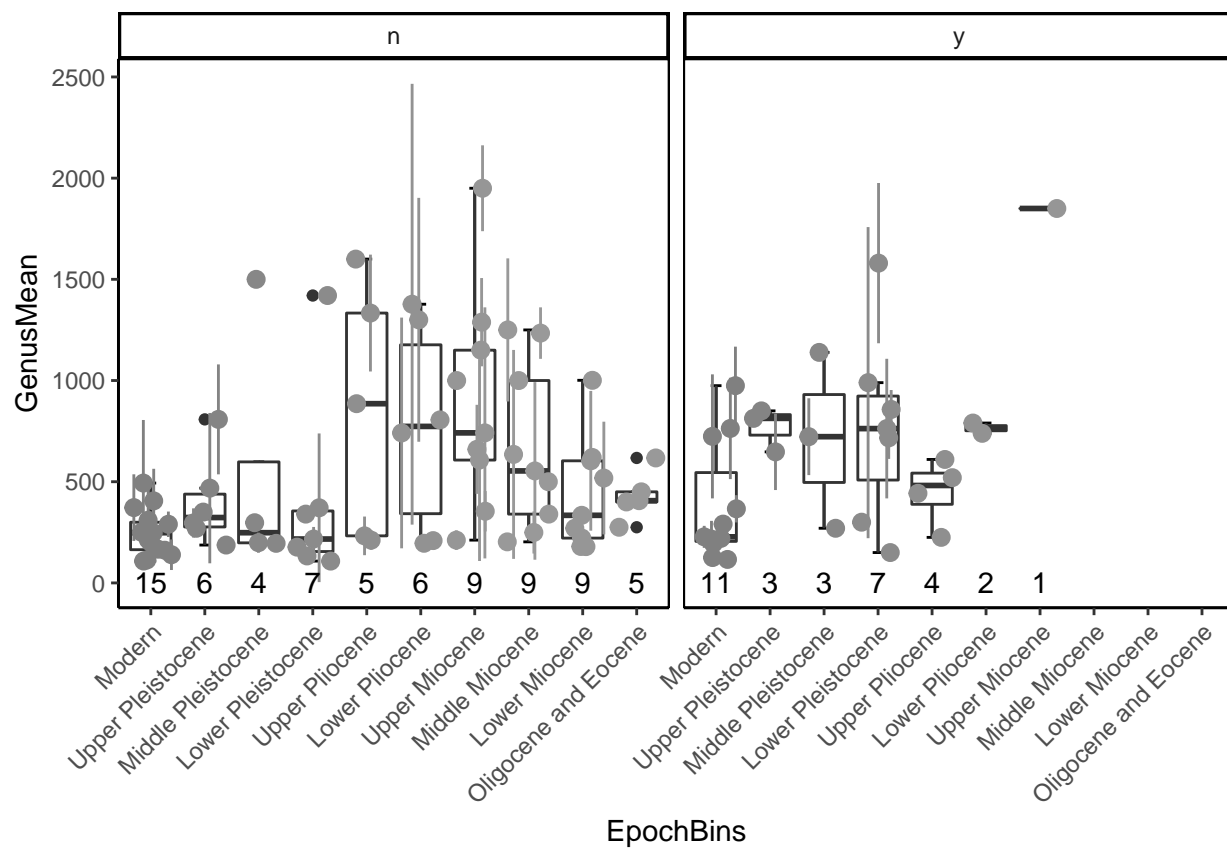
Figure 11: Boxplots of each genus per time bin, continental vs. insular species.

fossil vs. modern
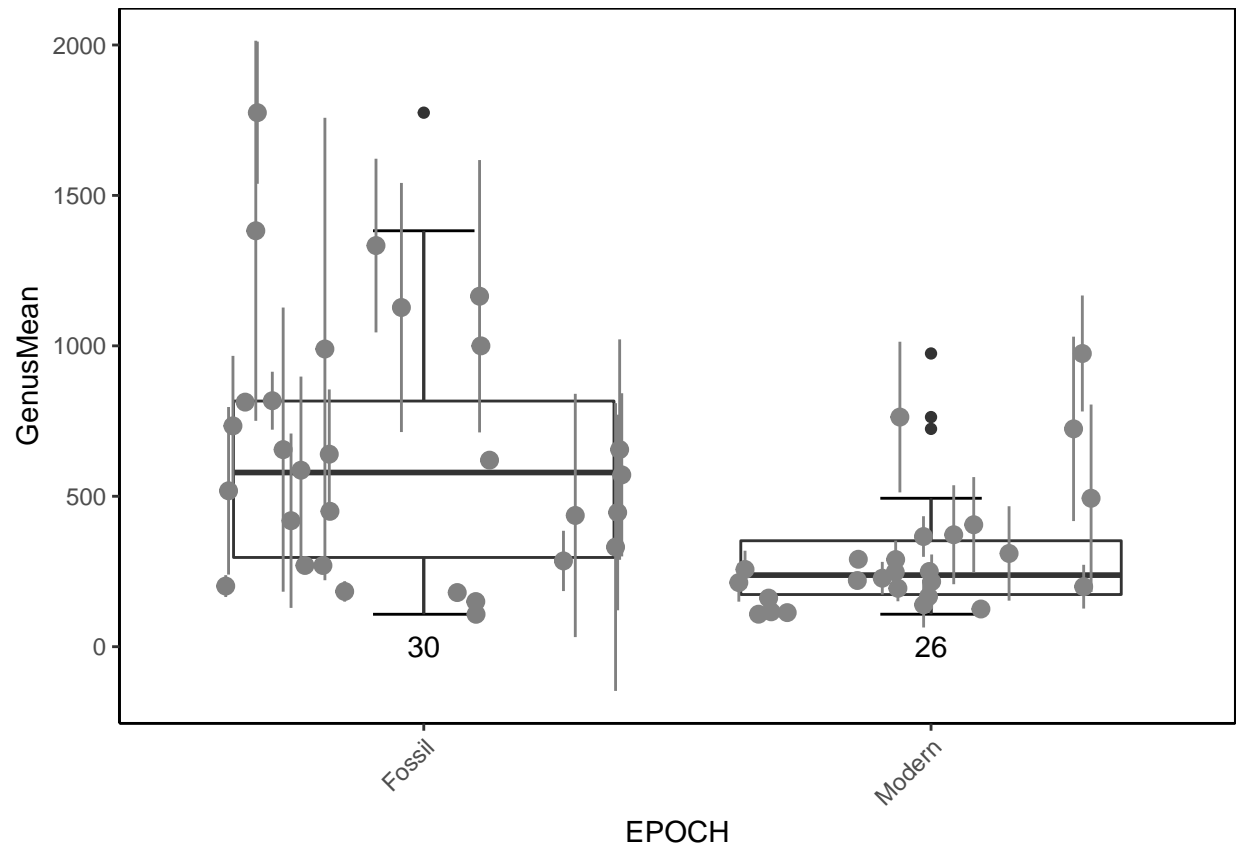
Figure 12: Boxplots fossil vs. modern.

fossil vs. modern, continental vs. insular
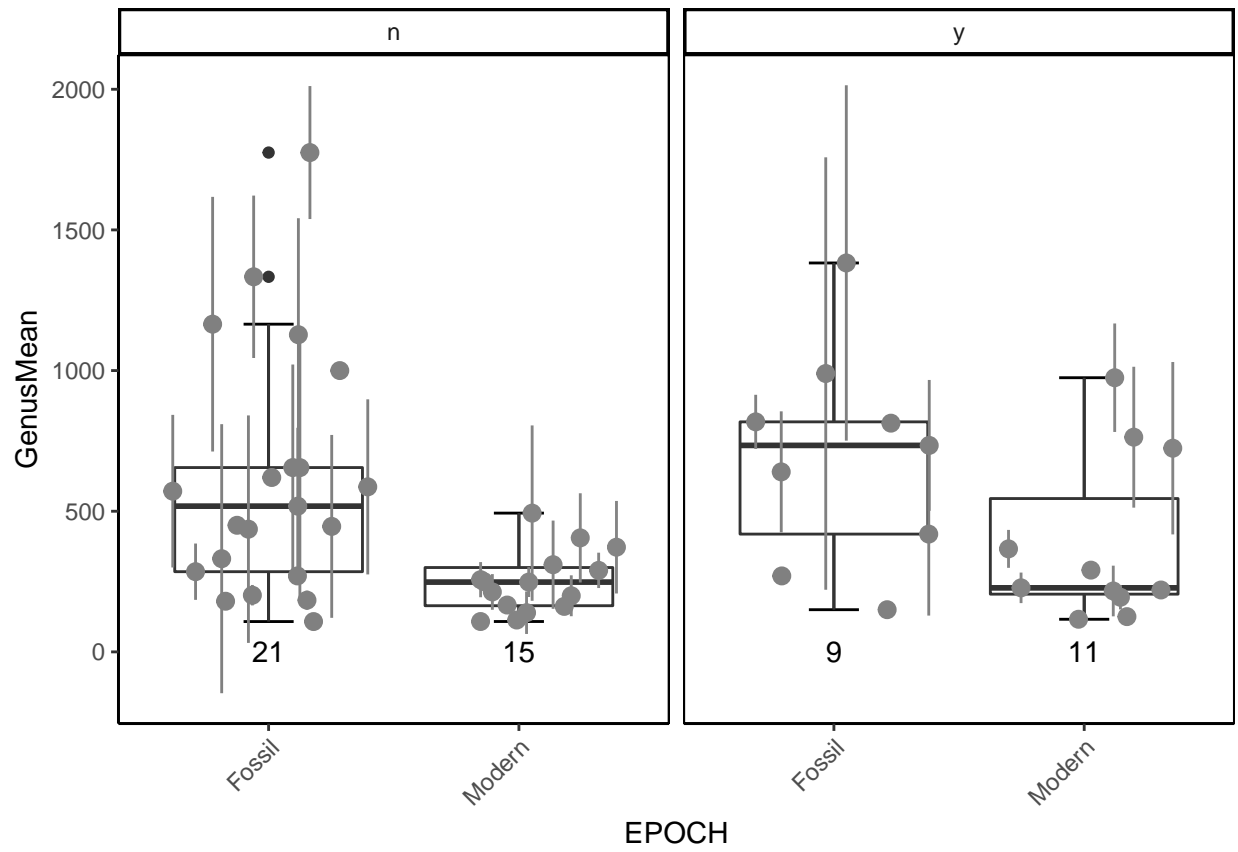
Figure 13: Boxplots fossil vs. modern, continental vs. insular species.

continental vs. insular
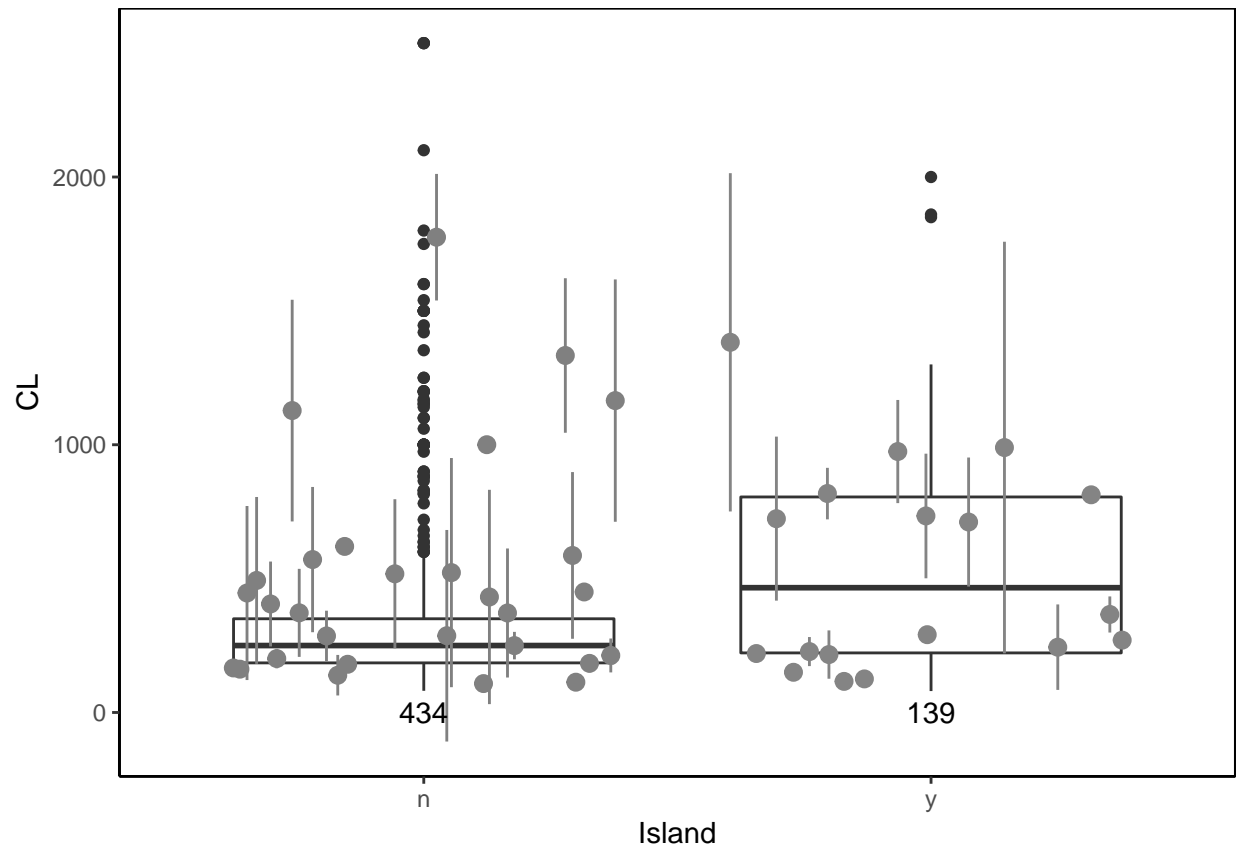
Figure 14: Boxplot continental vs. insular, genera summarised

continental vs. insular per time bin
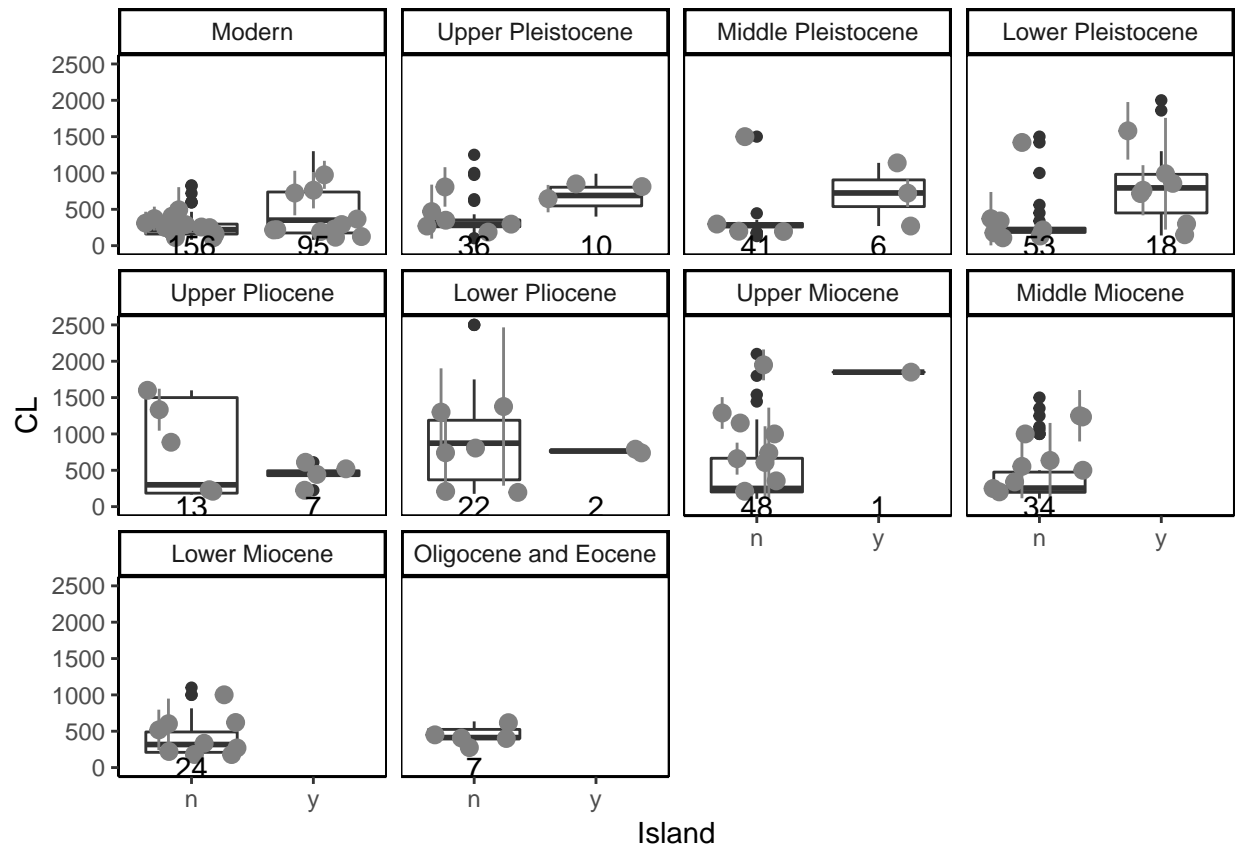
Figure 15: Boxplot continental vs. insular, genera summarised

continents
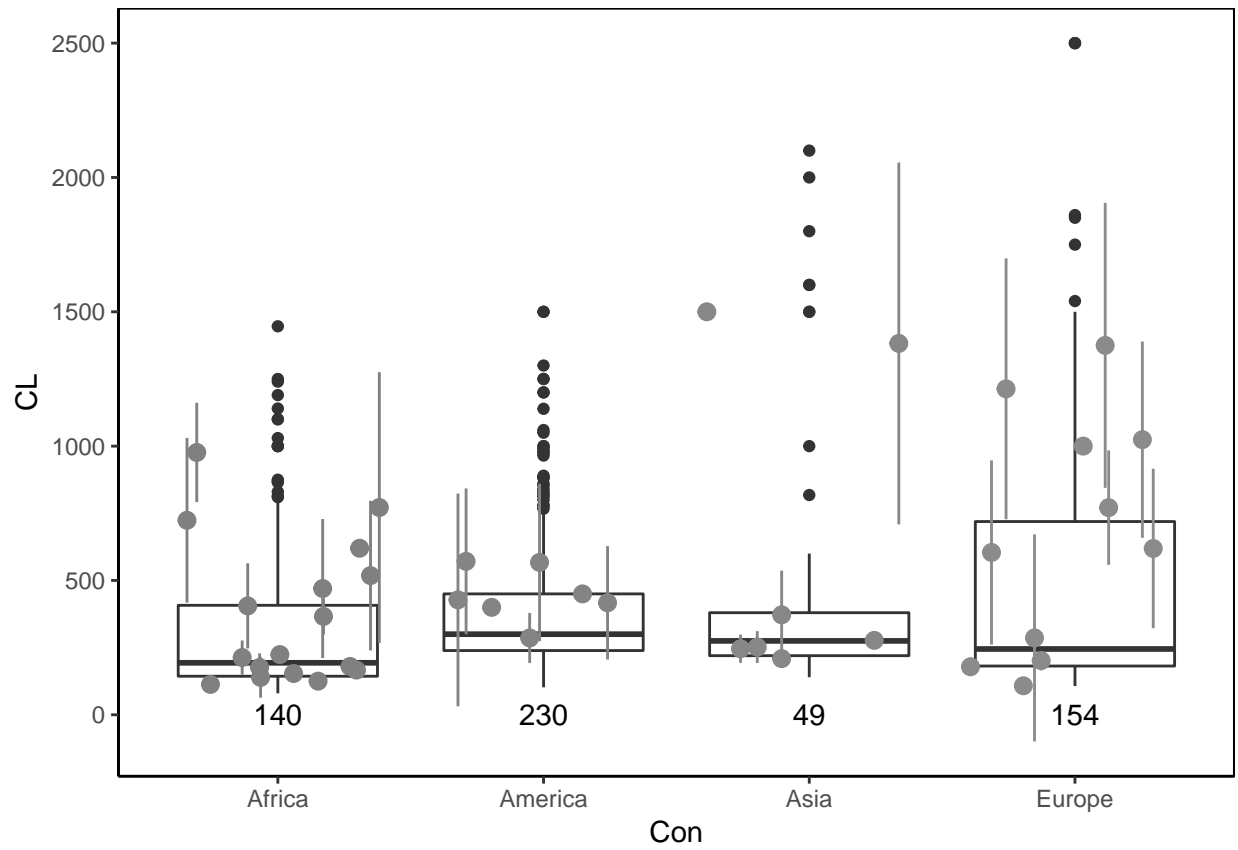
Figure 16: Boxplot: body size on different continents, genera summarised
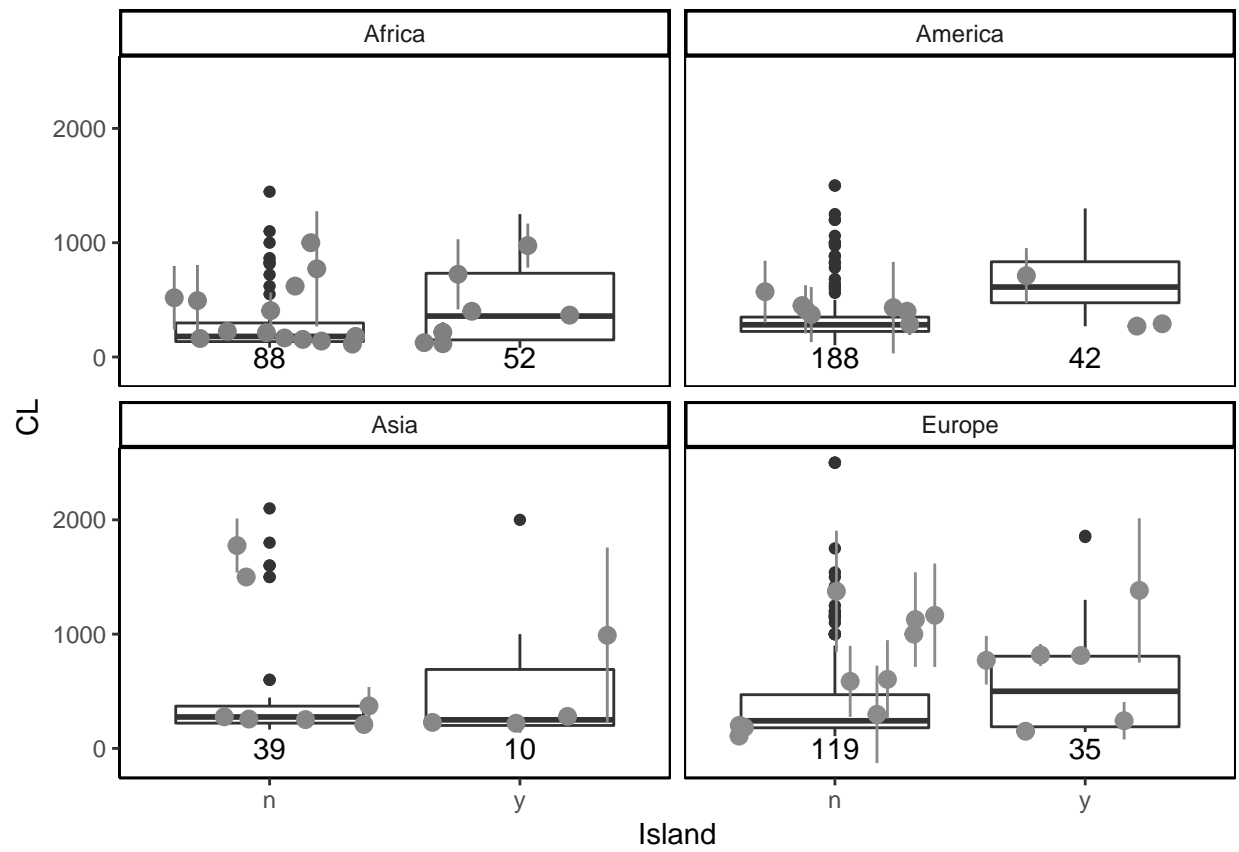
Figure 17: Boxplot: body size on different continents, genera summarised

paleoTS analysis

all (continental and insular)

individuals (all)
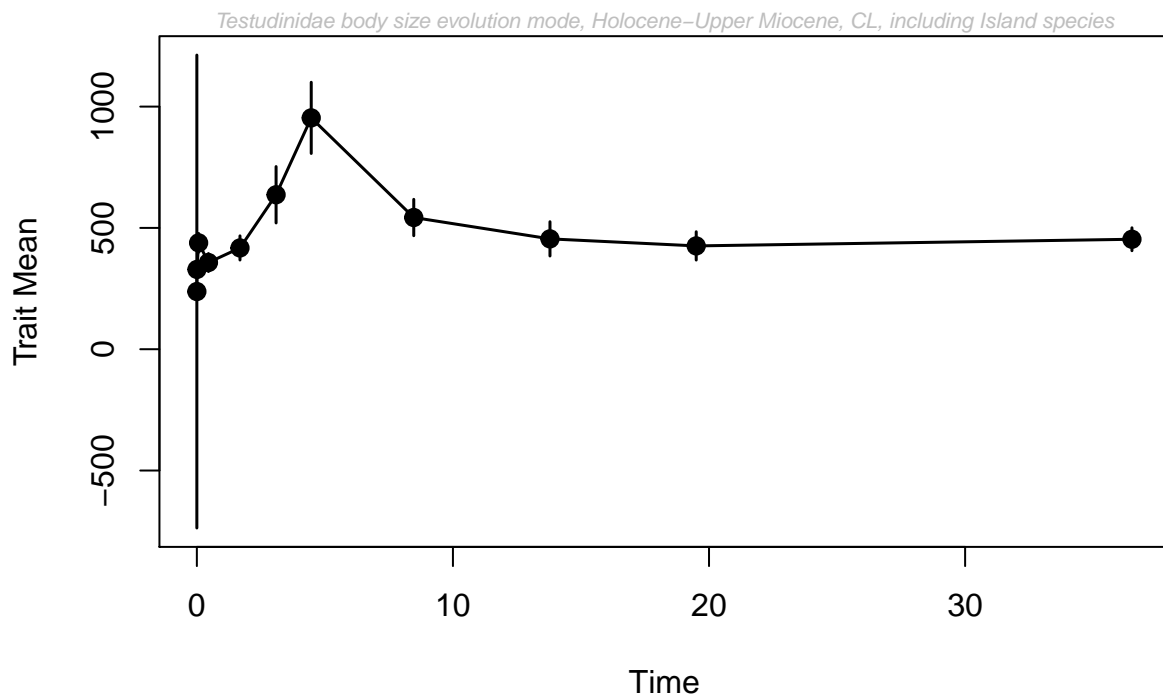
Figure 18: individuals, including island species

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

	logL	K	AICc	Akaike.wt
GRW	-68.07841	2	141.8711	0.008
URW	-68.07845	1	138.6569	0.040
Stasis	-63.29025	2	132.2948	0.952

Table 4: Model-fitting results for testudinidae (4 models), individuals, including island species

	logL	K	AICc	Akaike.wt
GRW	-68.07841	2	141.8711	0.008
URW	-68.07845	1	138.6569	0.039
Stasis	-63.29025	2	132.2948	0.949
StrictStasis	-70.35167	1	143.2033	0.004

species (all)

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

Table 5: Model-fitting results for testudinidae, species, including island species

	logL	K	AICc	Akaike.wt
GRW	-56.70310	2	119.4062	0.149
URW	-56.93847	1	116.4484	0.653
Stasis	-56.41523	2	118.8305	0.198

Table 6: Model-fitting results for testudinidae (4 models), species, including island species

	logL	K	AICc	Akaike.wt
GRW	-56.70310	2	119.4062	0.083
URW	-56.93847	1	116.4484	0.366
Stasis	-56.41523	2	118.8305	0.111
StrictStasis	-56.75290	1	116.0772	0.440

genera (all)

Testudinidae body size evolution mode, Holocene–Upper Miocene, genus mean CL

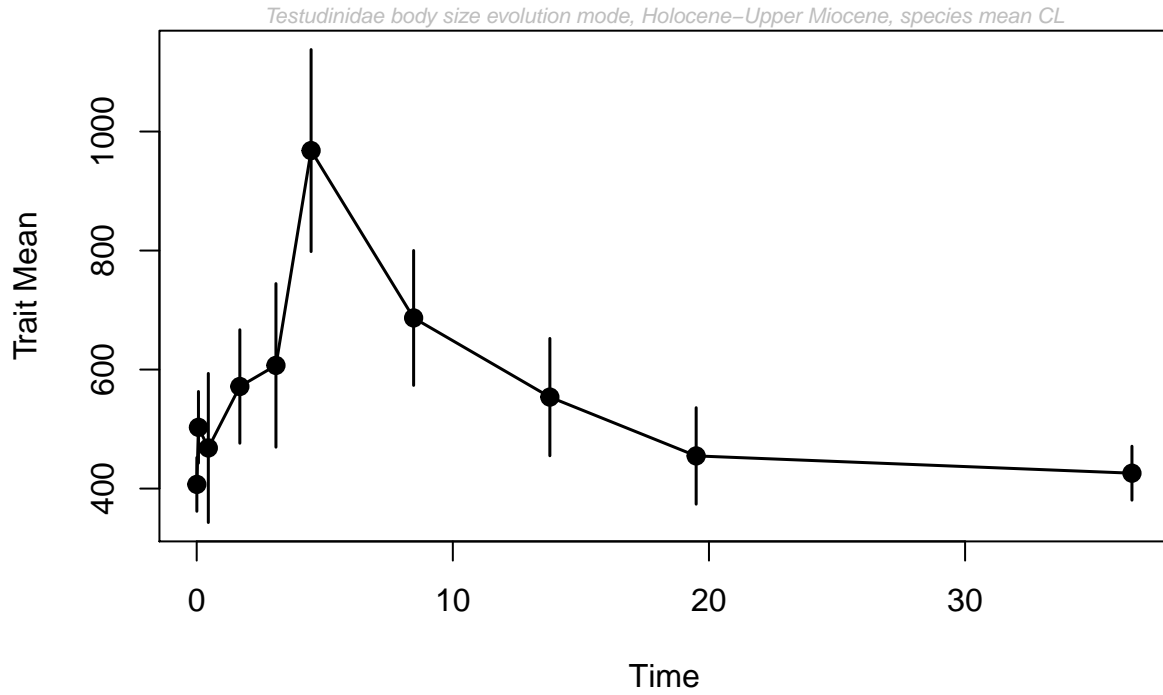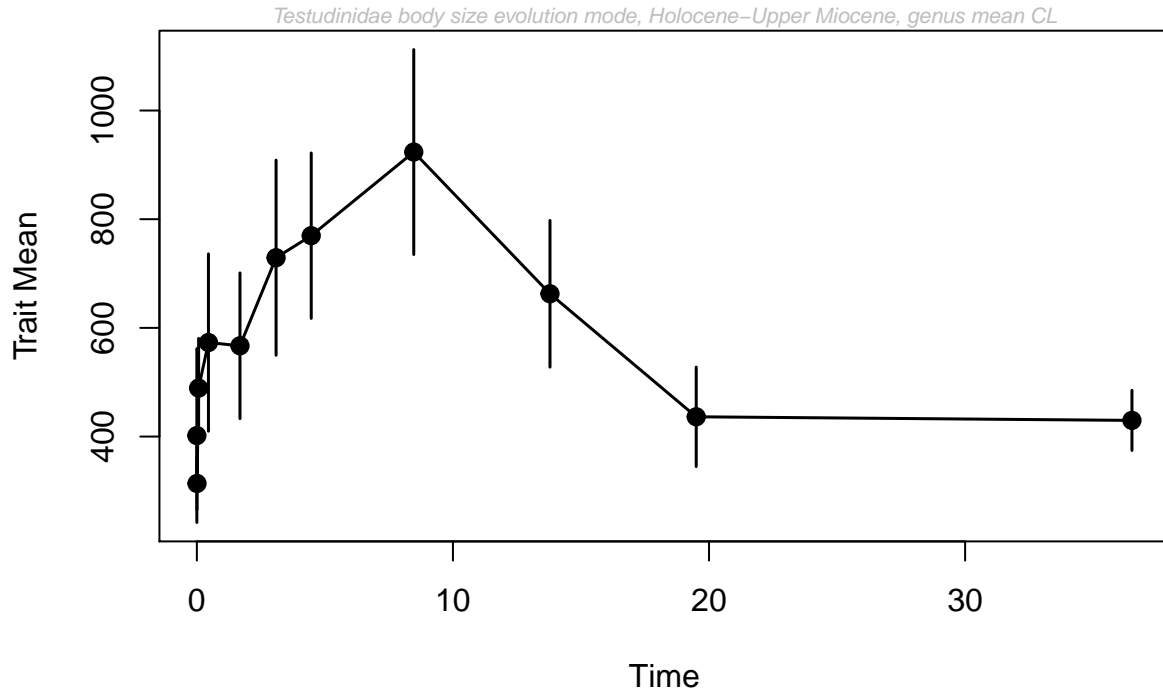Figure 20: paleoTS plot with genus mean, including island species

Table 7: Model-fitting results for testudinidae, genera, including island species

	logL	K	AICc	Akaike.wt
GRW	-64.78186	2	135.2780	0.166
URW	-64.86224	1	132.2245	0.766
Stasis	-65.68705	2	137.0884	0.067

Table 8: Model-fitting results for testudinidae (4 models), genera, including island species

	logL	K	AICc	Akaike.wt
GRW	-64.78186	2	135.2780	0.165
URW	-64.86224	1	132.2245	0.757
Stasis	-65.68705	2	137.0884	0.067
StrictStasis	-69.04466	1	140.5893	0.012

continental (excluding insular species)

individuals (continental)

Testudinidae body size evolution mode, Holocene–Upper Miocene, CL, including Island species
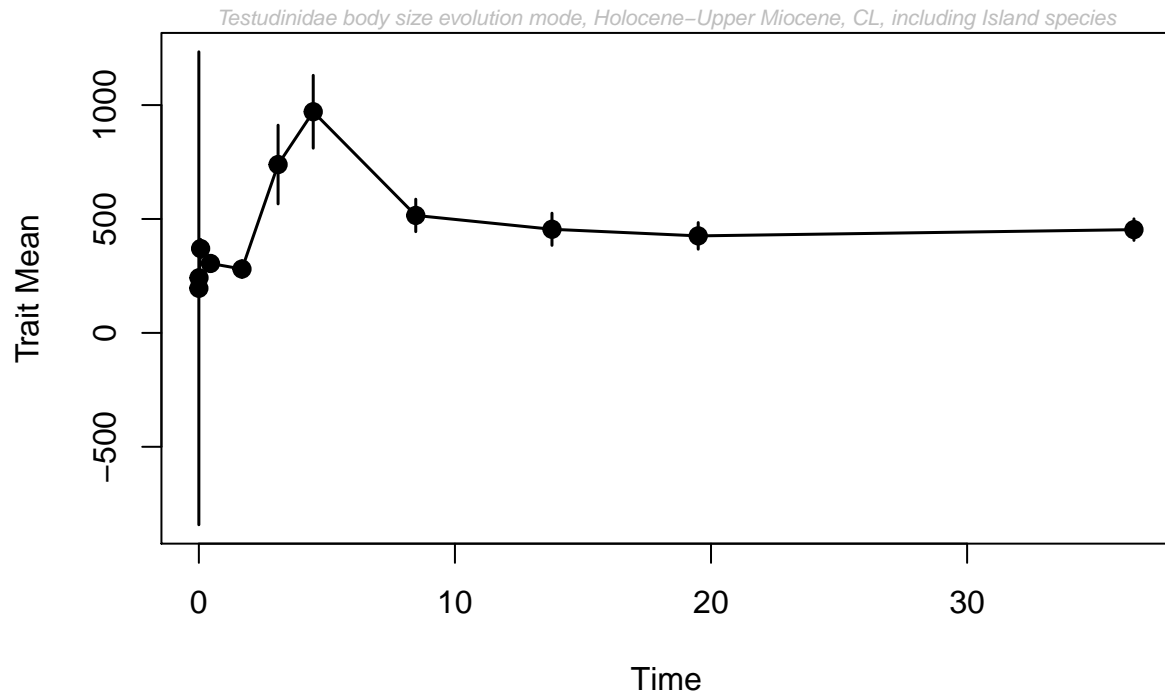
Figure 21: individuals, excluding island species

Table 9: Model-fitting results for testudinidae, individuals, excluding island species

	logL	K	AICc	Akaike.wt
GRW	-70.13728	2	145.9888	0.018
URW	-70.14070	1	142.7814	0.090
Stasis	-66.24073	2	138.1957	0.892

Table 10: Model-fitting results for testudinidae (4 models), individuals, excluding island species

	logL	K	AICc	Akaike.wt
GRW	-70.13728	2	145.9888	0.018
URW	-70.14070	1	142.7814	0.090
Stasis	-66.24073	2	138.1957	0.892
StrictStasis	-89.86176	1	182.2235	0.000

species (continental)

Testudinidae body size evolution mode, Holocene–Upper Miocene, species mean CL, continental
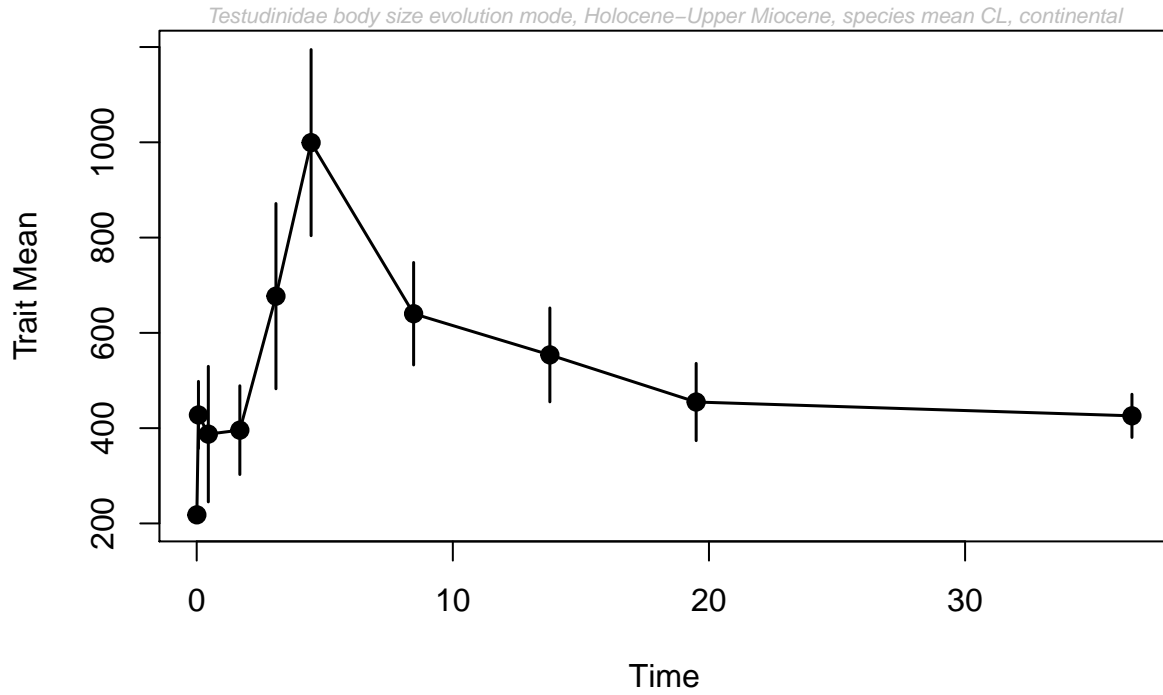
Figure 22: paleoTS plot with species mean, excluding island species

Table 11: Model-fitting results for testudinidae, species, excluding island species

	logL	K	AICc	Akaike.wt
GRW	-60.91398	2	127.8280	0.020
URW	-62.36871	1	127.3088	0.026
Stasis	-57.04727	2	120.0945	0.954

Table 12: Model-fitting results for testudinidae, species, excluding island species

	logL	K	AICc	Akaike.wt
GRW	-60.91398	2	127.8280	0.003
URW	-62.36871	1	127.3088	0.004
Stasis	-57.04727	2	120.0945	0.151
StrictStasis	-57.04727	1	116.6660	0.841

genera (continental)

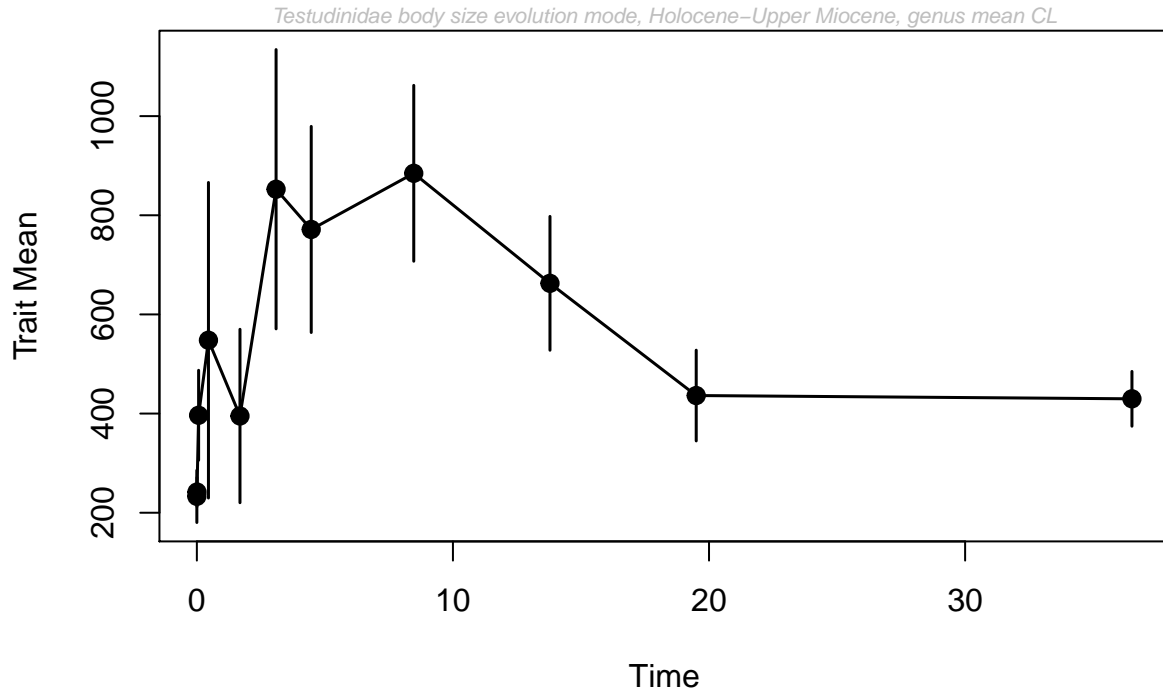*Testudinidae body size evolution mode, Holocene–Upper Miocene, genus mean CL*

Figure 23: paleoTS plot with genus mean, excluding island species

Table 13: Model-fitting results for testudinidae, genera, excluding insular species

	logL	K	AICc	Akaike.wt
GRW	-65.94462	2	137.6035	0.175
URW	-66.03667	1	134.5733	0.796
Stasis	-67.73195	2	141.1782	0.029

Table 14: Model-fitting results for testudinidae, genera, excluding insular species

	logL	K	AICc	Akaike.wt
GRW	-65.94462	2	137.6035	0.175
URW	-66.03667	1	134.5733	0.796
Stasis	-67.73195	2	141.1782	0.029
StrictStasis	-76.85009	1	156.2002	0.000

insular (excluding continental)
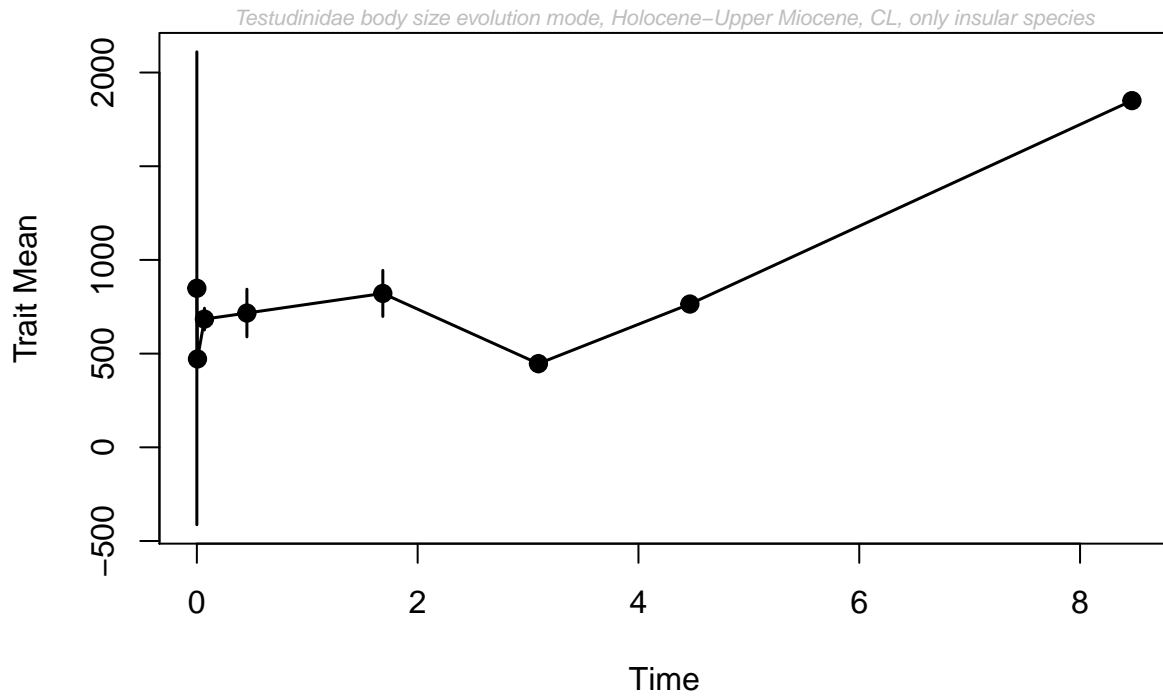
individuals (insular)

Figure 24: individuals, excluding continental species

Table 15: Model-fitting results for testudinidae, individuals, only insular species

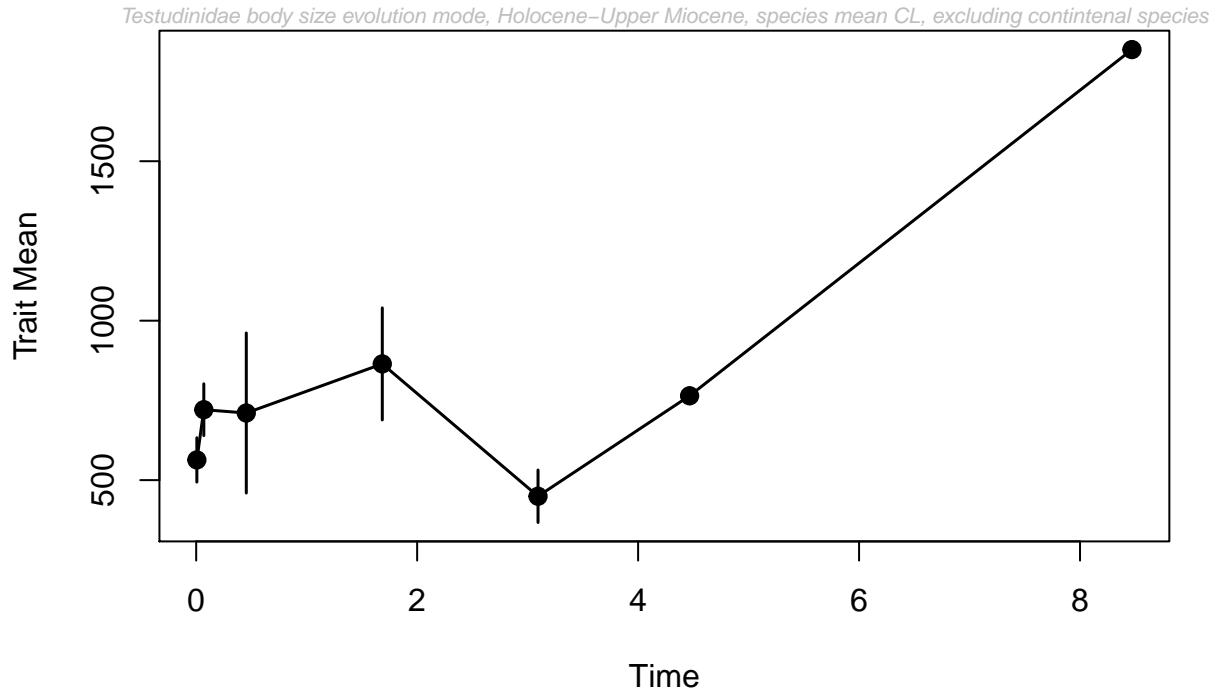|	logL	K	AICc	Akaike.wt
GRW	-62.23202	2	131.4640	0.000
URW	-52.89195	1	108.5839	0.999
Stasis	-58.14309	2	123.2862	0.001

species (insular)

Figure 25: paleoTS plot with species mean, only insular species

Table 16: Model-fitting results for testudinidae, species, only insular species

	logL	K	AICc	Akaike.wt
GRW	-42.69525	2	93.39049	0.194
URW	-43.79116	1	90.58232	0.791
Stasis	-45.31346	2	98.62692	0.014

genera (insular)

Testudinidae body size evolution mode, Holocene–Upper Miocene, genus mean CL, insular genera
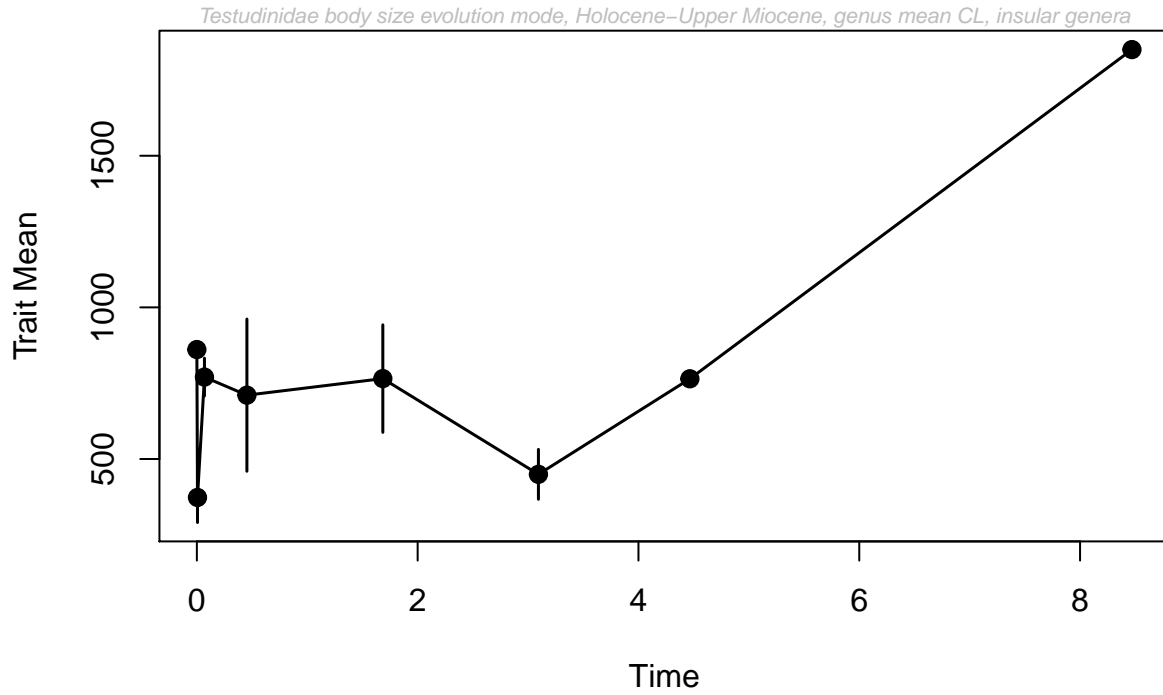
Figure 26: paleoTS plot with genus mean, only insular species

Table 17: Model-fitting results for testudinidae, genera, only insular species

	logL	K	AICc	Akaike.wt
GRW	-60.79557	2	128.5911	0
URW	-67.79820	1	138.3964	0
Stasis	-52.91882	2	112.8376	1

play with time bins: no bins (mean age of each sample == tt)
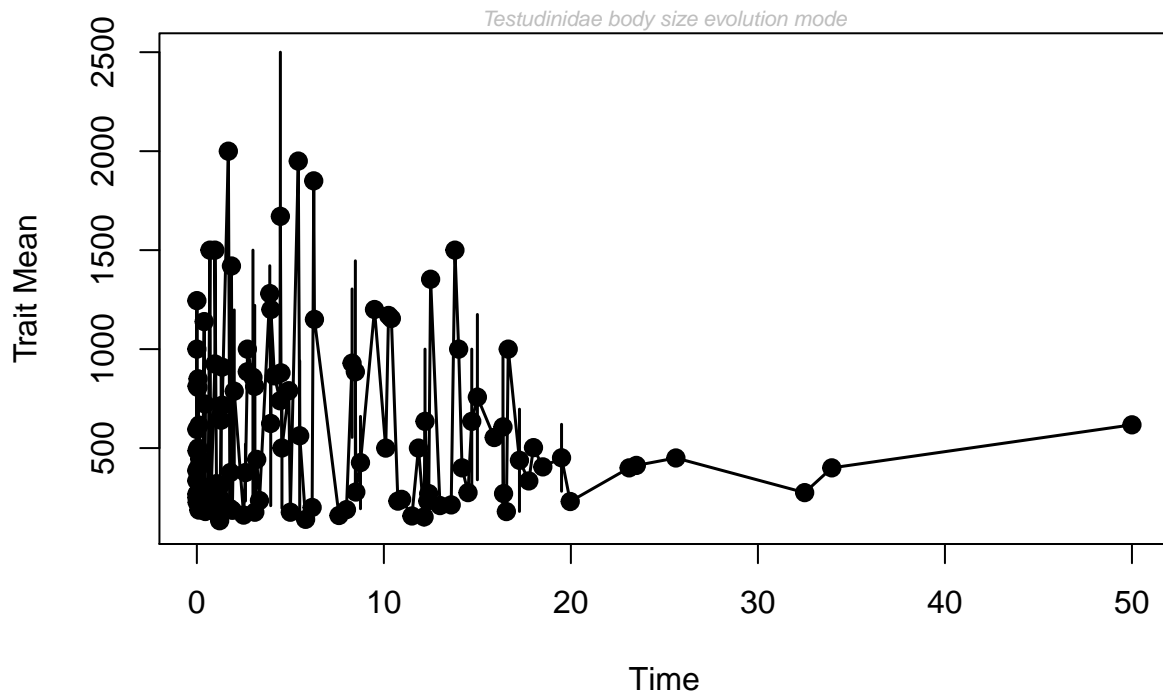
all

Figure 27: Mean age of each sample as time bin, genera

Table 18: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-6948.0075	2	13900.126	0
URW	-8243.1398	1	16488.316	0
Stasis	-885.7773	2	1775.666	1

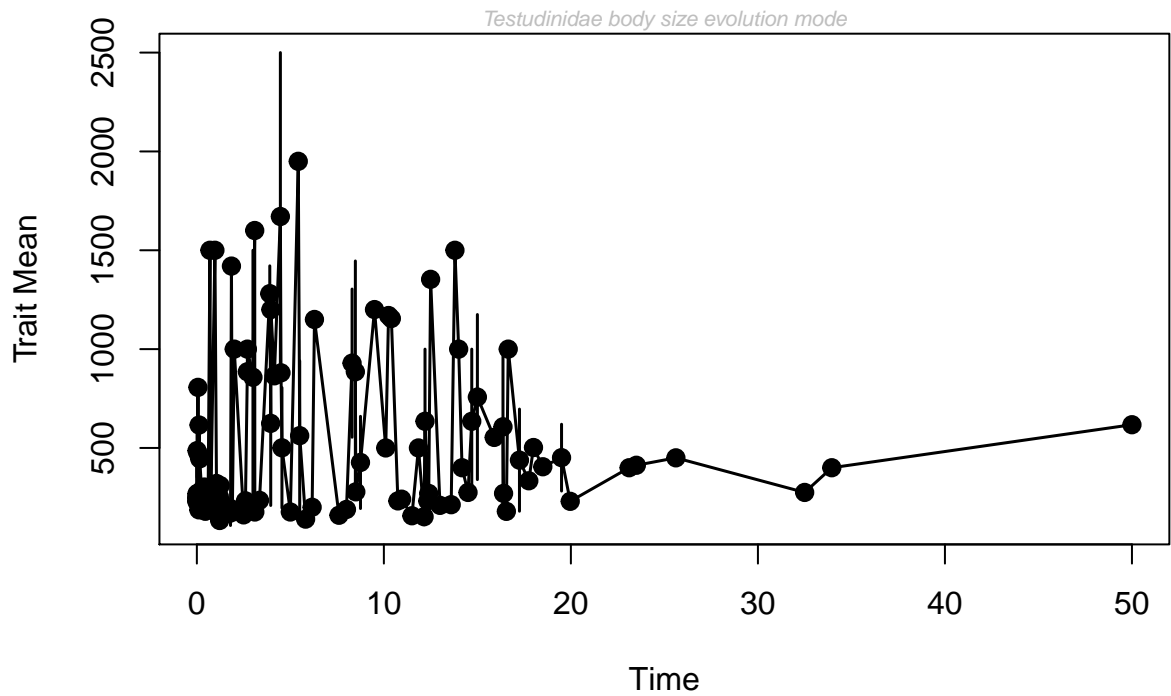**continental (no bins)**

Testudinidae body size evolution mode

Figure 28: Mean age of each sample as time bin, genera, continental

Table 19: Model-fitting results for testudinidae, no bins, genera, continental

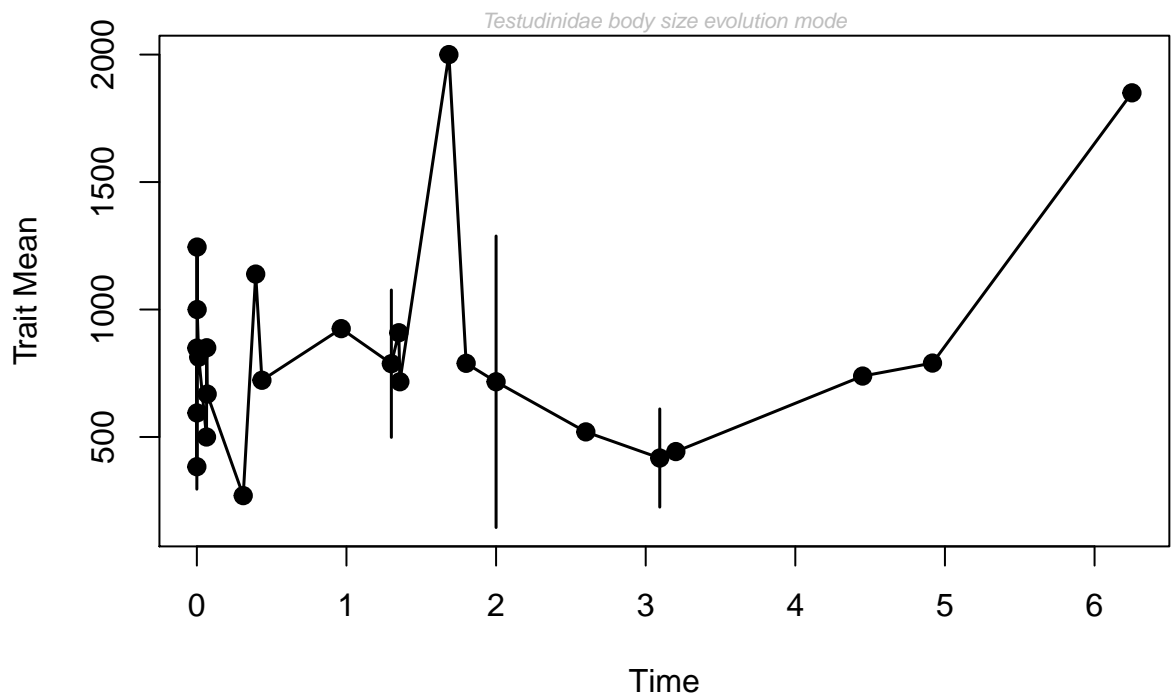|	logL	K	AICc	Akaike.wt
GRW	-782.8522	2	1569.836	0
URW	-782.8541	1	1567.752	0
Stasis	-704.9241	2	1413.980	1

insular (no bins)

Figure 29: Mean age of each sample as time bin, genera, insular

Table 20: Model-fitting results for testudinidae, no bins, genera, insular

	logL	K	AICc	Akaike.wt
GRW	-3723.151	2	7450.8734	0
URW	-11230.978	1	22464.1373	0
Stasis	-187.450	2	379.4714	1

Equal time bins

individuals (equal bins)

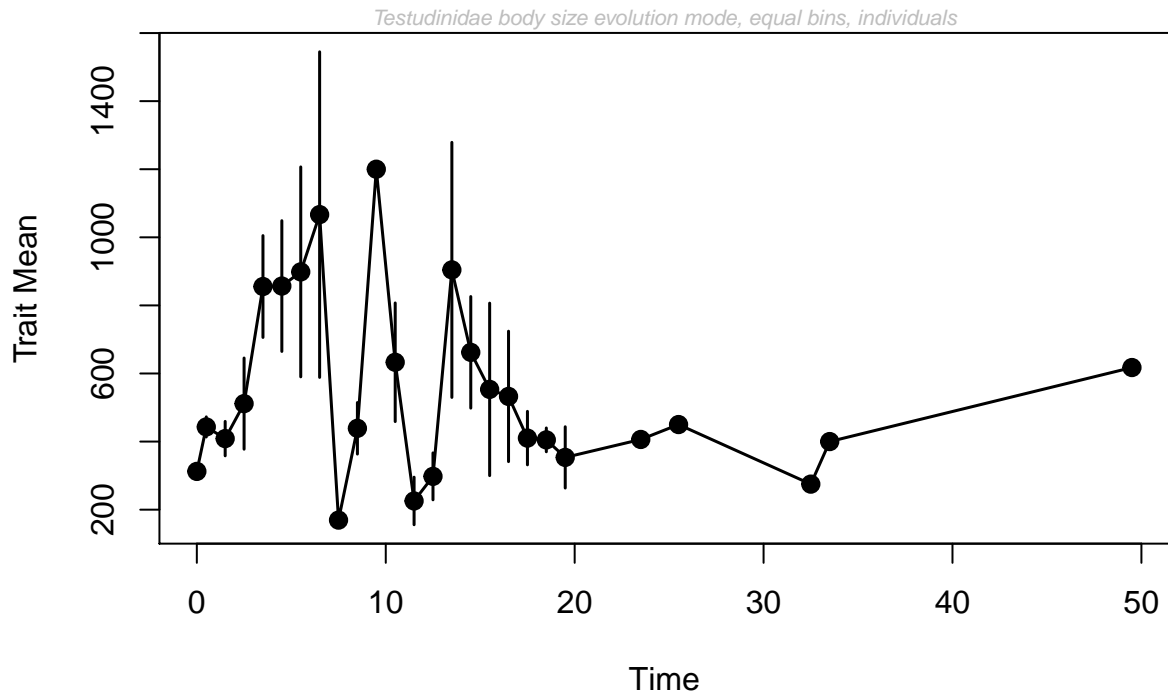Figure 30: Equal bins, individuals

Table 21: Model-fitting results for testudinidae, equal time bins, individuals

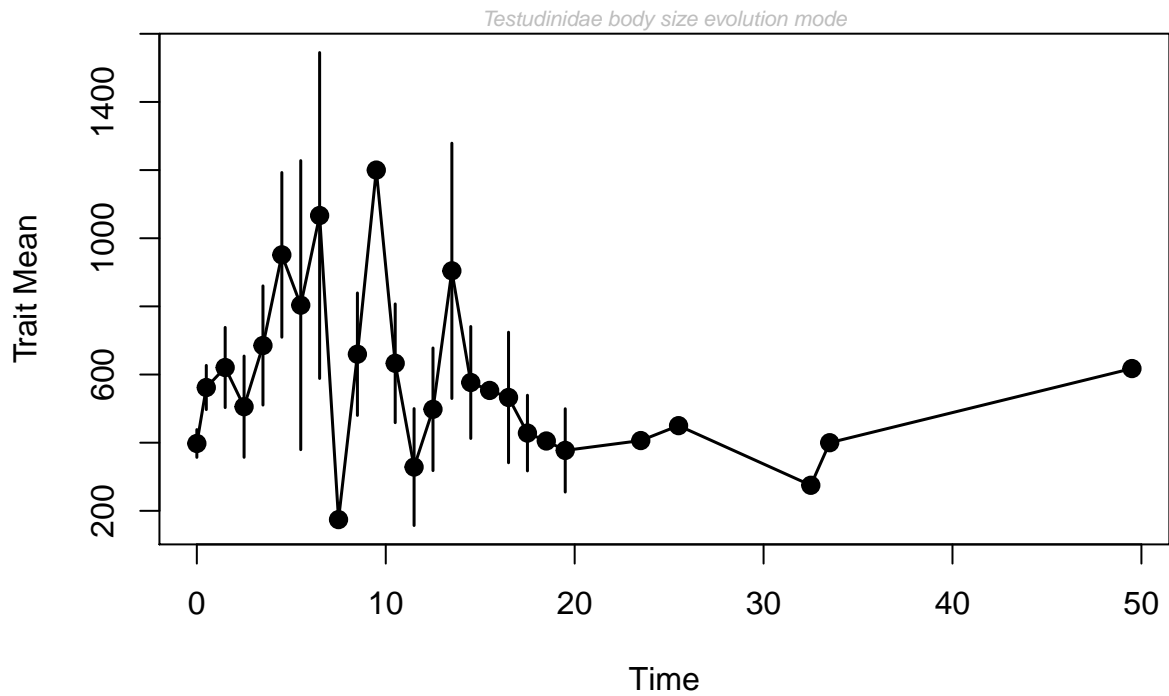|	logL	K	AICc	Akaike.wt
GRW	-181.0860	2	366.7174	0.001
URW	-182.5837	1	367.3413	0.001
Stasis	-174.2101	2	352.9656	0.998

species (equal bins)

Figure 31: Equal bins, species

Table 22: Model-fitting results for testudinidae, equal time bins, species

	logL	K	AICc	Akaike.wt
GRW	-177.3909	2	359.3272	0.011
URW	-178.7626	1	359.6991	0.010
Stasis	-172.9454	2	350.4363	0.979

genera (equal bins)
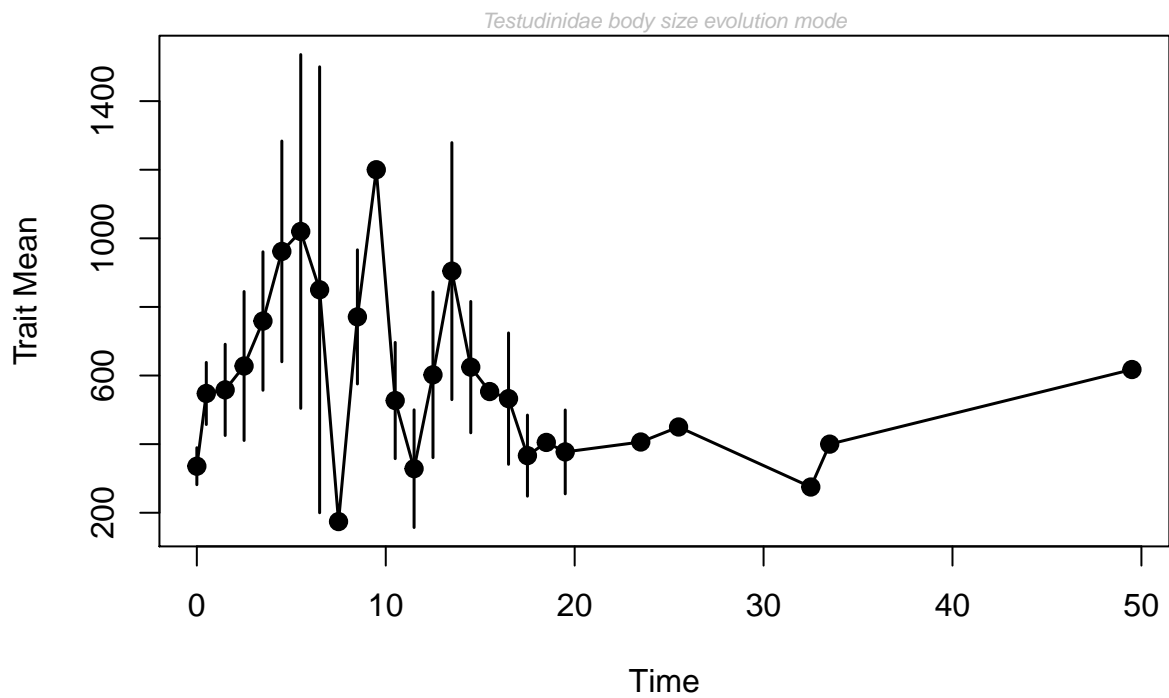

Figure 32: Equal bins, genera

Table 23: Model-fitting results for testudinidae, equal time bins, genera

	logL	K	AICc	Akaike.wt
GRW	-179.4504	2	363.4462	0.008
URW	-178.8180	1	359.8099	0.051
Stasis	-174.7233	2	353.9921	0.940

larger equal bins
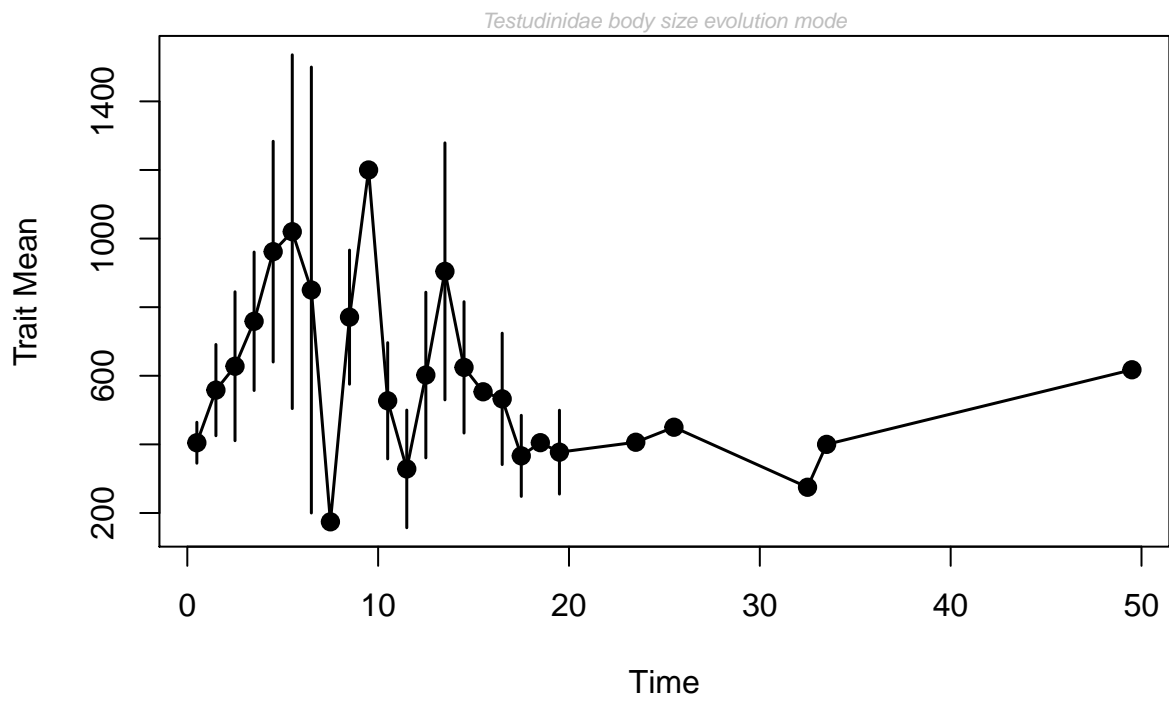
genera (larger equal bins)

Figure 33: Larger equal bins, genera

Table 24: Model-fitting results for testudinidae, larger equal time bins, genera

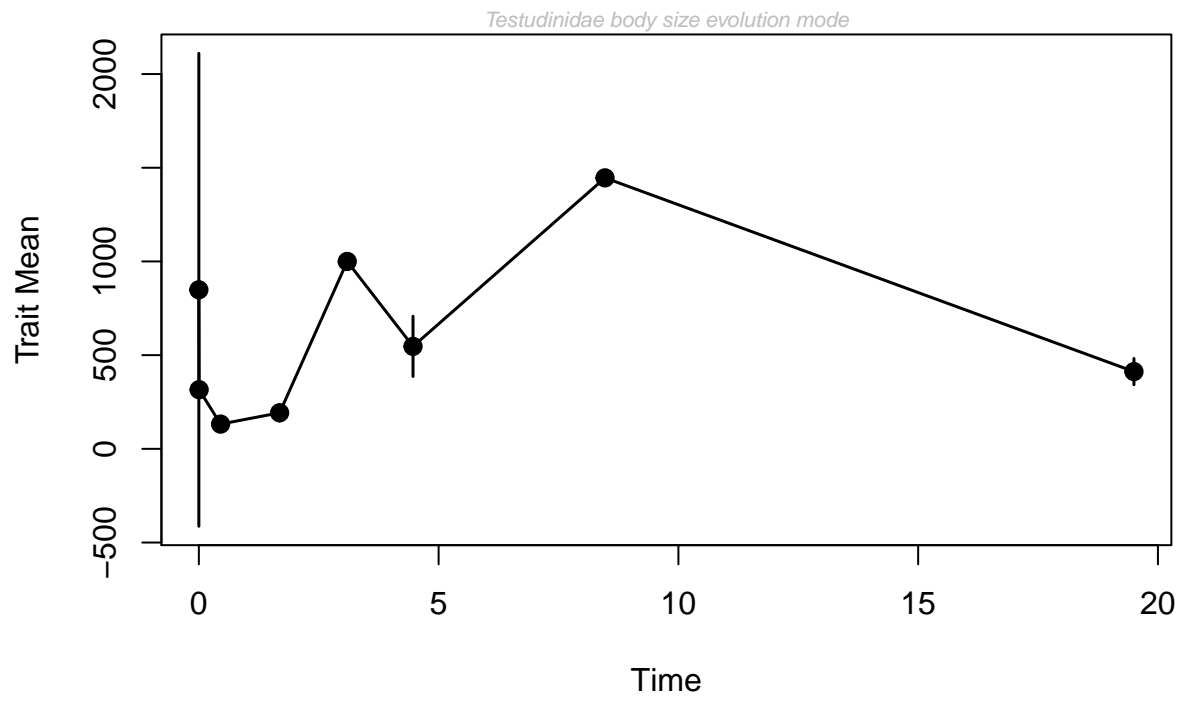|	logL	K	AICc	Akaike.wt
GRW	-172.6279	2	349.8272	0.036
URW	-172.9972	1	348.1763	0.082
Stasis	-169.4260	2	343.4234	0.882

per continent

Africa, individuals

Figure 34: Africa, individuals

Table 25: Model-fitting results for testudinidae, individuals, Africa

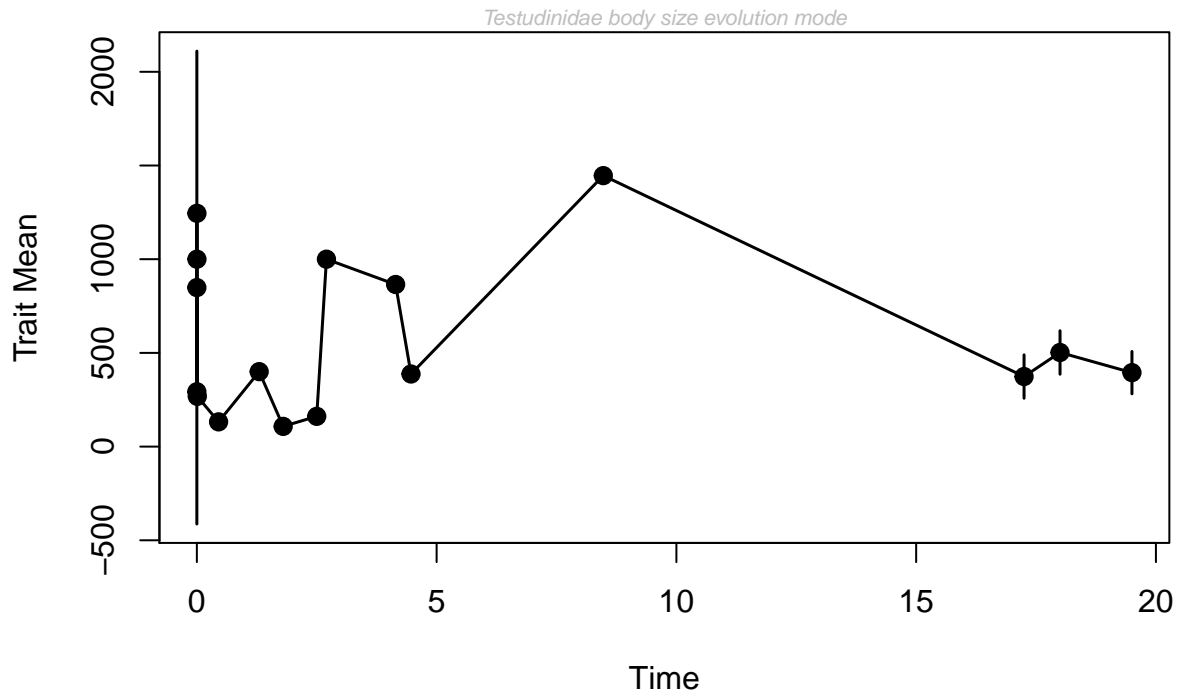|	logL	K	AICc	Akaike.wt
GRW	-55.31925	2	117.6385	0.621
URW	-57.92754	1	118.6551	0.373
Stasis	-59.96849	2	126.9370	0.006

Africa, no bins, individuals

Figure 35: Africa, individuals, no bins

Table 26: Model-fitting results for testudinidae, individuals, no bins, Africa

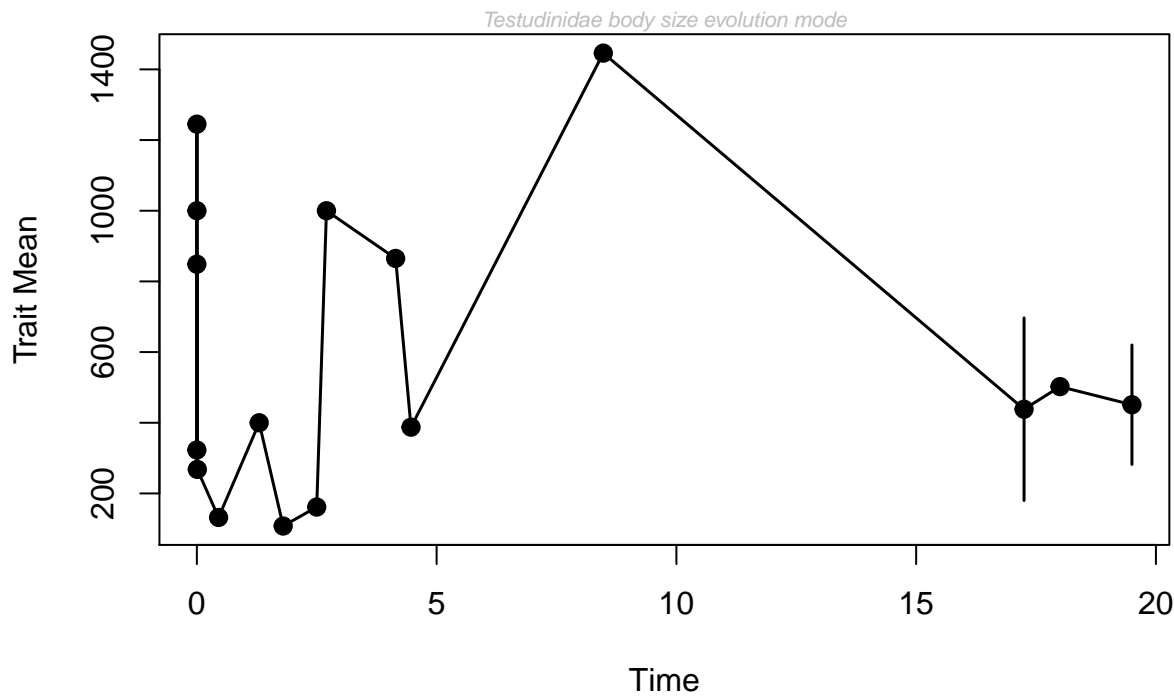|	logL	K	AICc	Akaike.wt
GRW	-1025.9662	2	2056.9323	0
URW	-2572.3987	1	5147.1052	0
Stasis	-130.7568	2	266.5135	1

Africa, no bins, genera

Figure 36: Mean age of each sample as time bin, genera, Africa

Table 27: Model-fitting results for testudinidae, no bins, genera

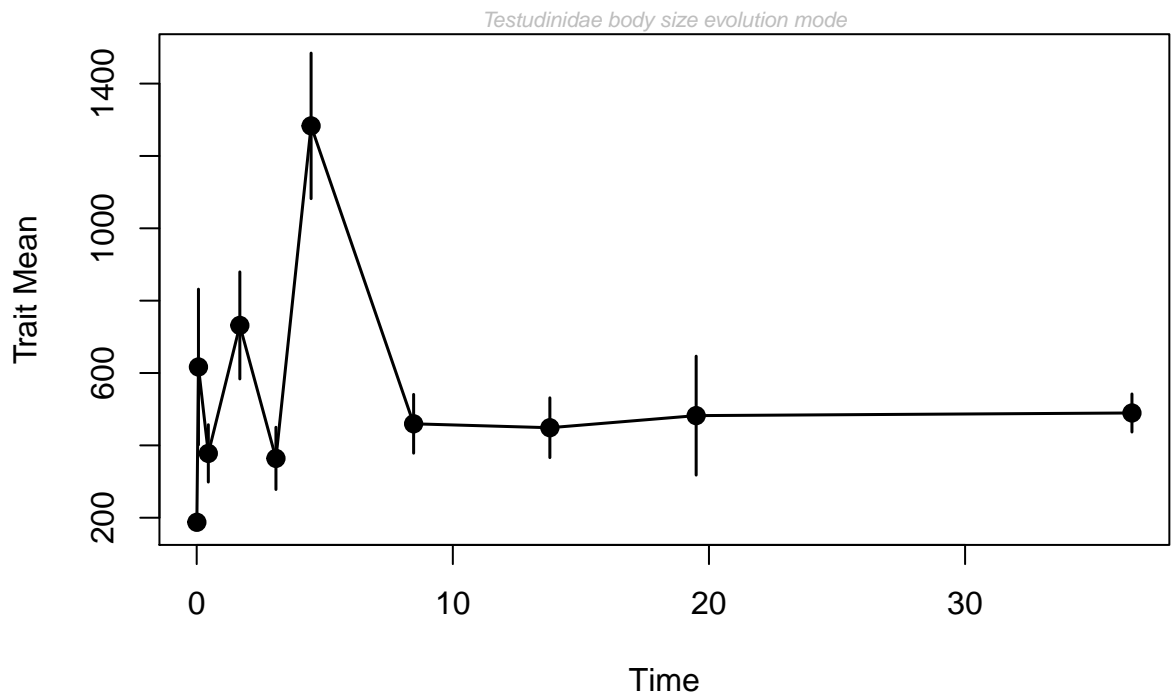|	logL	K	AICc	Akaike.wt
GRW	-221.6685	2	448.3369	0
URW	-167.7116	1	337.7309	0
Stasis	-111.6921	2	228.3842	1

Figure 37: Europe, individuals

Table 28: Model-fitting results for testudinidae, individuals, Europe

	logL	K	AICc	Akaike.wt
GRW	-70.32825	2	146.6565	0.000
URW	-70.88581	1	144.3430	0.001
Stasis	-61.87920	2	129.7584	0.999

Table 29: Model-fitting results for testudinidae, individuals, Europe

	logL	K	AICc	Akaike.wt
GRW	-70.32825	2	146.6565	0.000
URW	-70.88581	1	144.3430	0.000

	logL	K	AICc	Akaike.wt
Stasis	-61.87920	2	129.7584	0.187
StrictStasis	-62.12633	1	126.8241	0.812

Testudinidae body size evolution mode
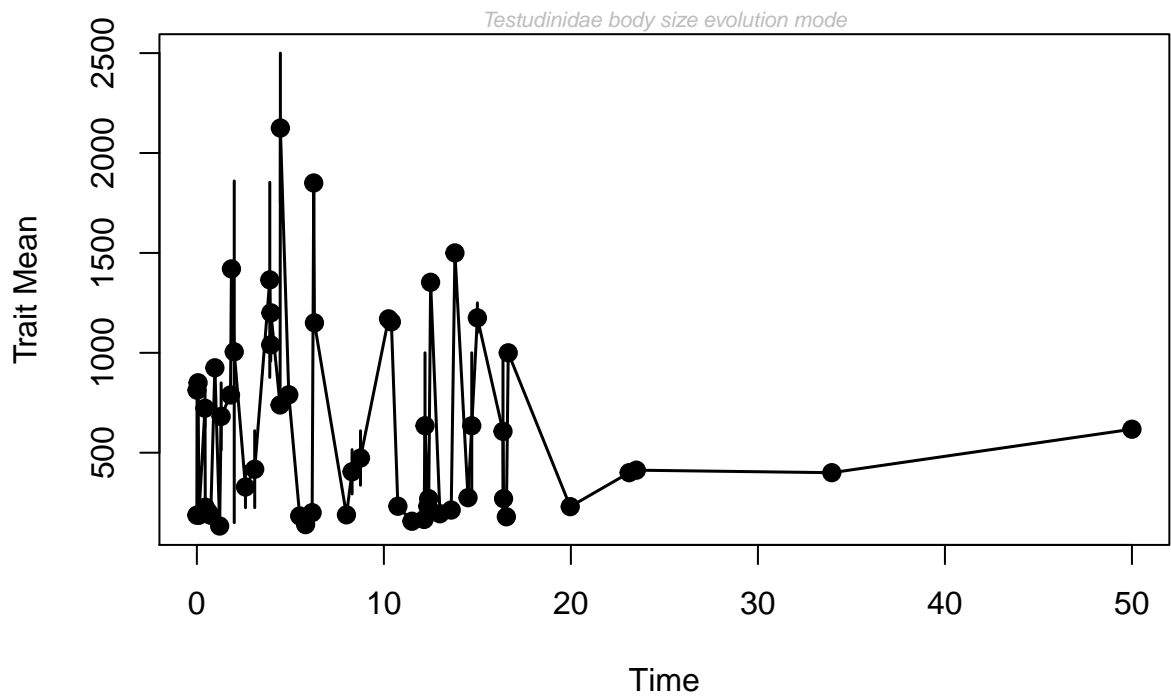
Figure 38: Europe, individuals, no bins

Table 30: Model-fitting results for testudinidae, individuals, no bins, Europe

	logL	K	AICc	Akaike.wt
GRW	-447.9212	2	900.0777	0
URW	-447.9212	1	897.9194	0
Stasis	-409.6032	2	823.4417	1

Testudinidae body size evolution mode
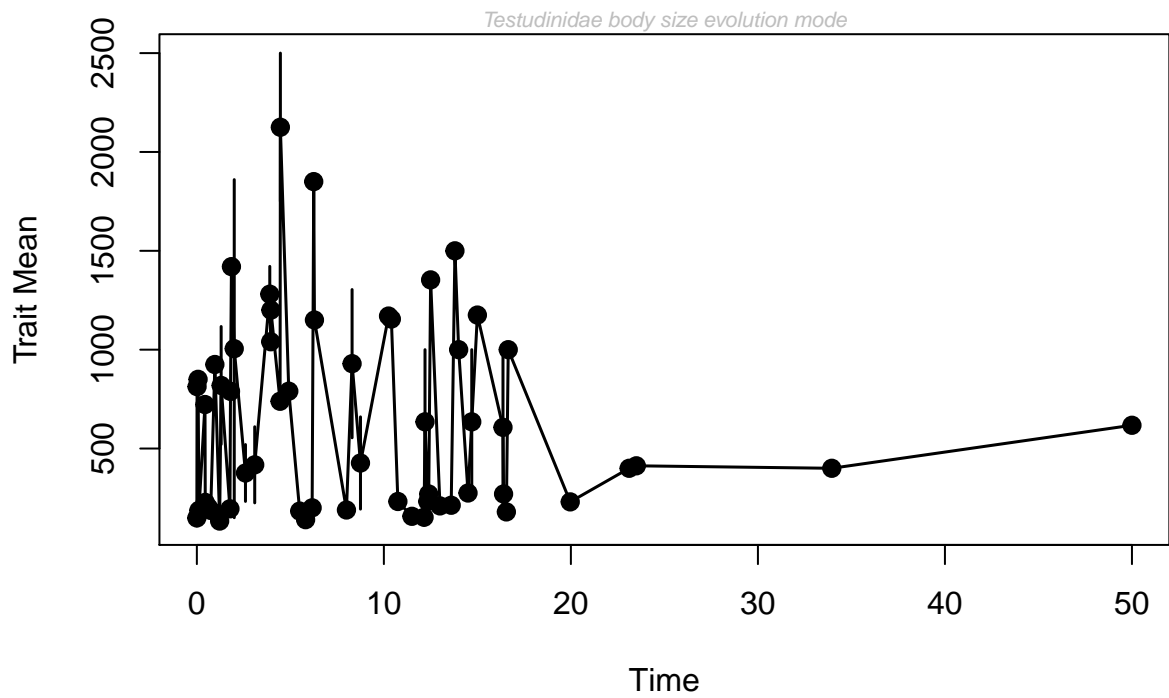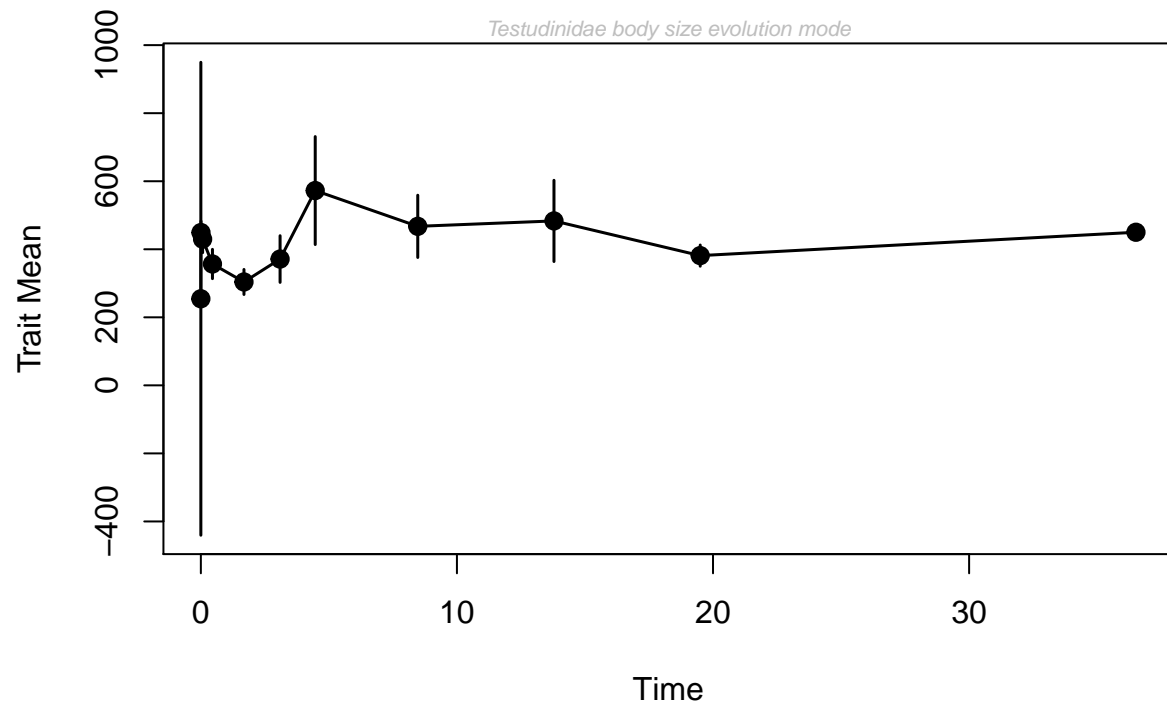
Figure 39: Mean age of each sample as time bin, genera,Europe

Table 31: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-872.4874	2	1749.2013	0
URW	-767.6493	1	1537.3727	0
Stasis	-457.9671	2	920.1606	1

America, individuals (2nd try)

Testudinidae body size evolution mode
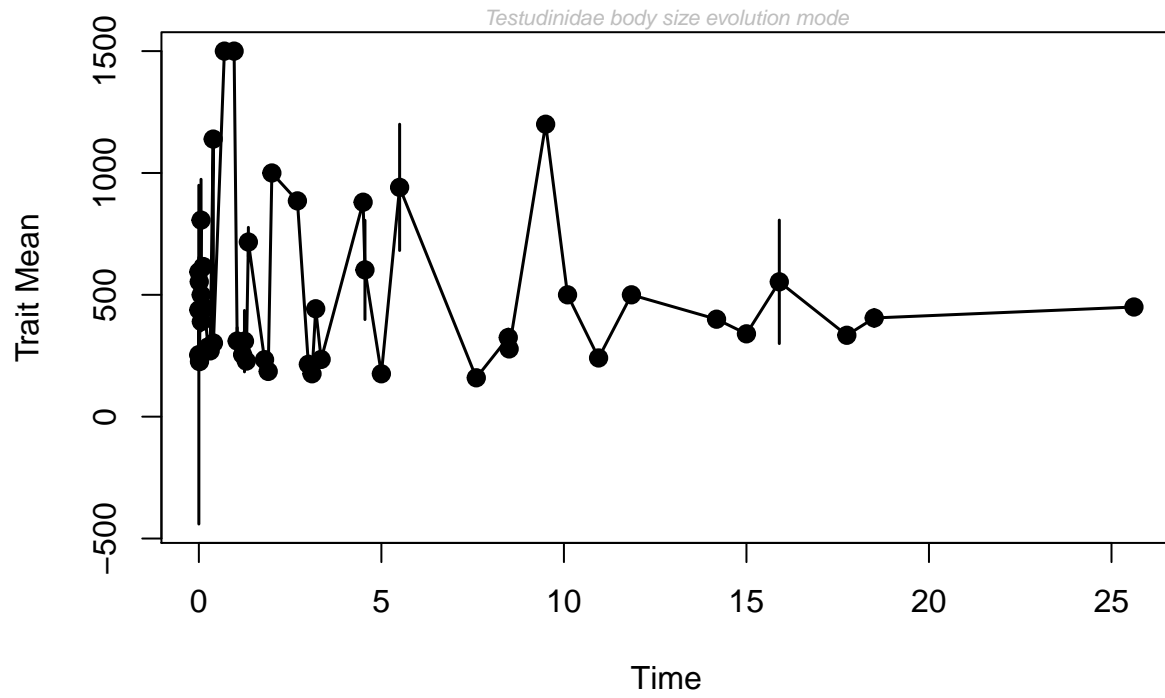
fits don't work, no idea why

Figure 40: America, individuals, no bins

Table 32: Model-fitting results for testudinidae, individuals, no bins, America

	logL	K	AICc	Akaike.wt
GRW	-849.0212	2	1702.3215	0
URW	-765.5466	1	1533.1840	0
Stasis	-334.8158	2	673.9107	1

Testudinidae body size evolution mode
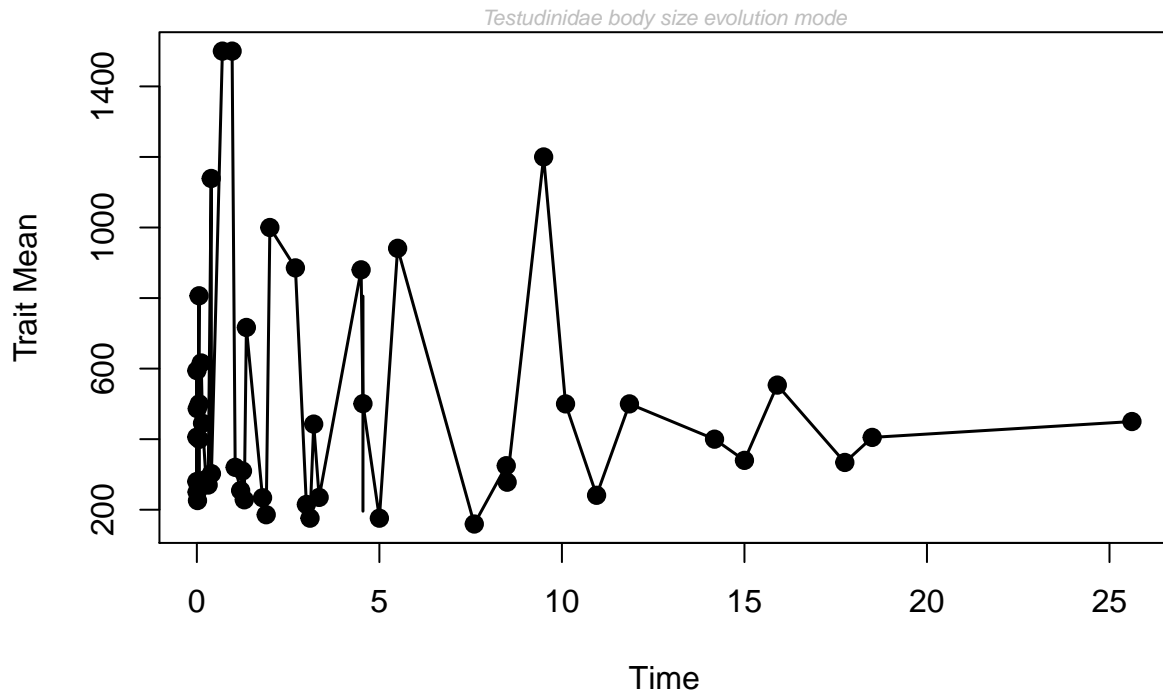
Figure 41: Mean age of each sample as time bin, genera, America

Table 33: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-374.4593	2	753.1977	0
URW	-374.4593	1	751.0095	0
Stasis	-336.1186	2	676.5163	1

52

Asia, individuals
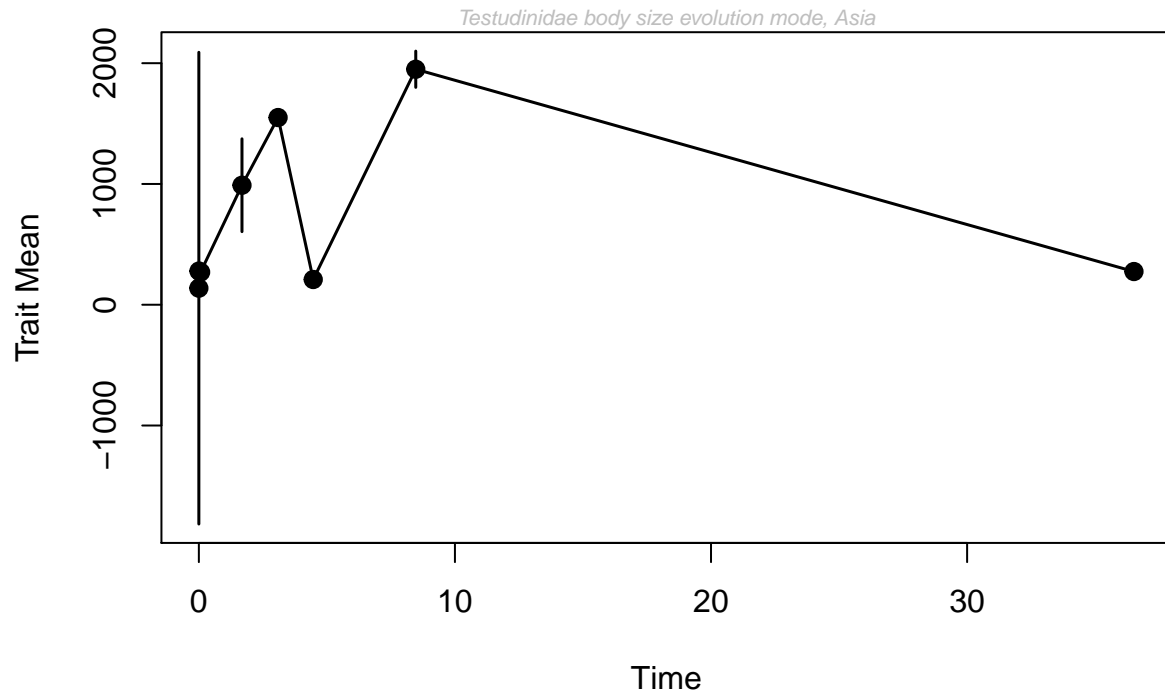

Figure 42: individuals, Asia

Table 34: Model-fitting results for testudinidae, individuals, Asia

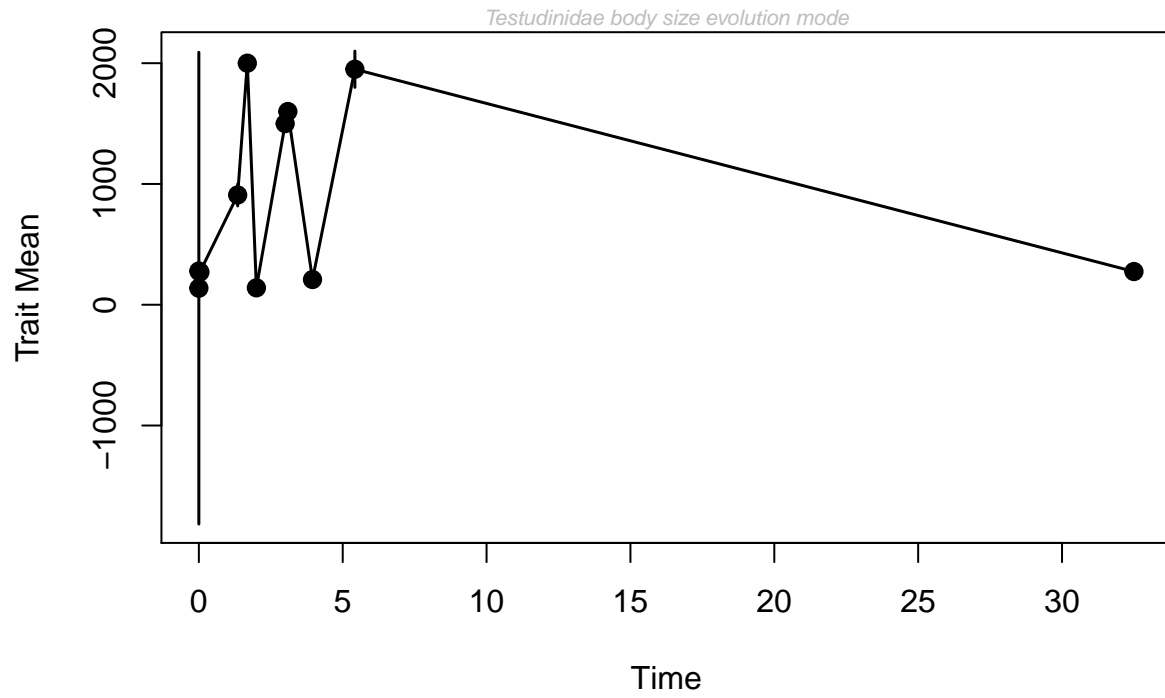|	logL	K	AICc	Akaike.wt
GRW	-80.46824	2	167.9365	0
URW	-58.38546	1	119.5709	1
Stasis	-66.94216	2	140.8843	0

Figure 43: Asia, individuals, no bins

Table 35: Model-fitting results for testudinidae, individuals, no bins, Asia

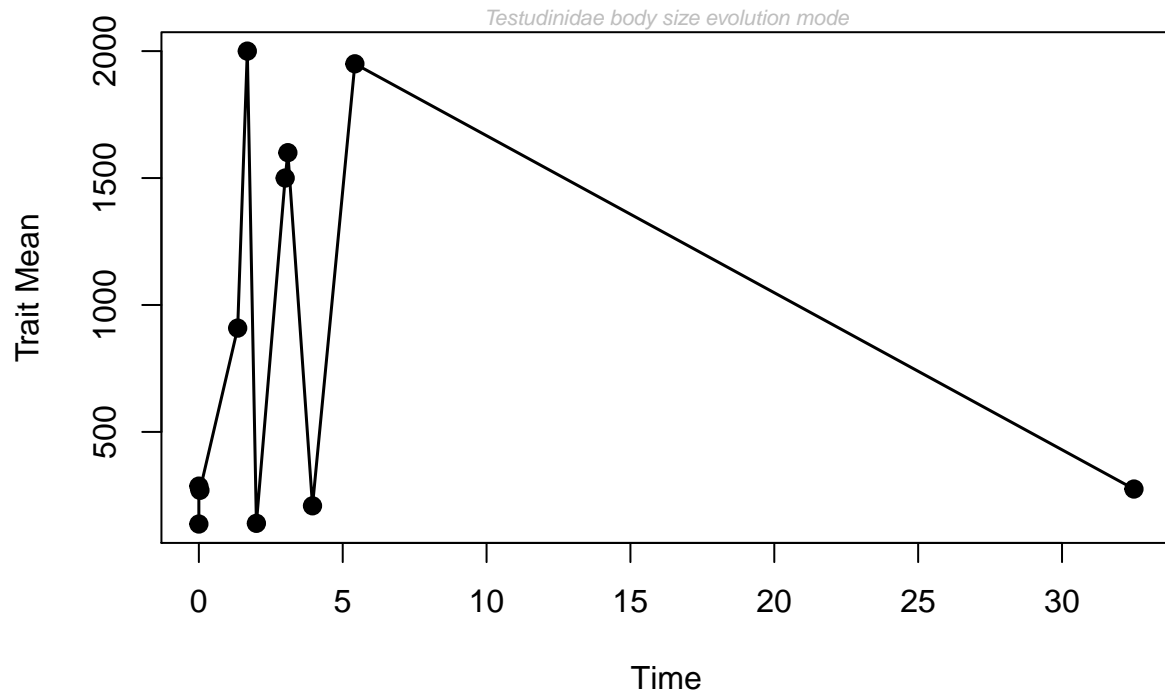|	logL	K	AICc	Akaike.wt
GRW	-131.87801	2	269.4703	0
URW	-132.23396	1	266.9679	0
Stasis	-87.44222	2	180.5987	1

Figure 44: Mean age of each sample as time bin, genera, Asia

Table 36: Model-fitting results for testudinidae, no bins, genera

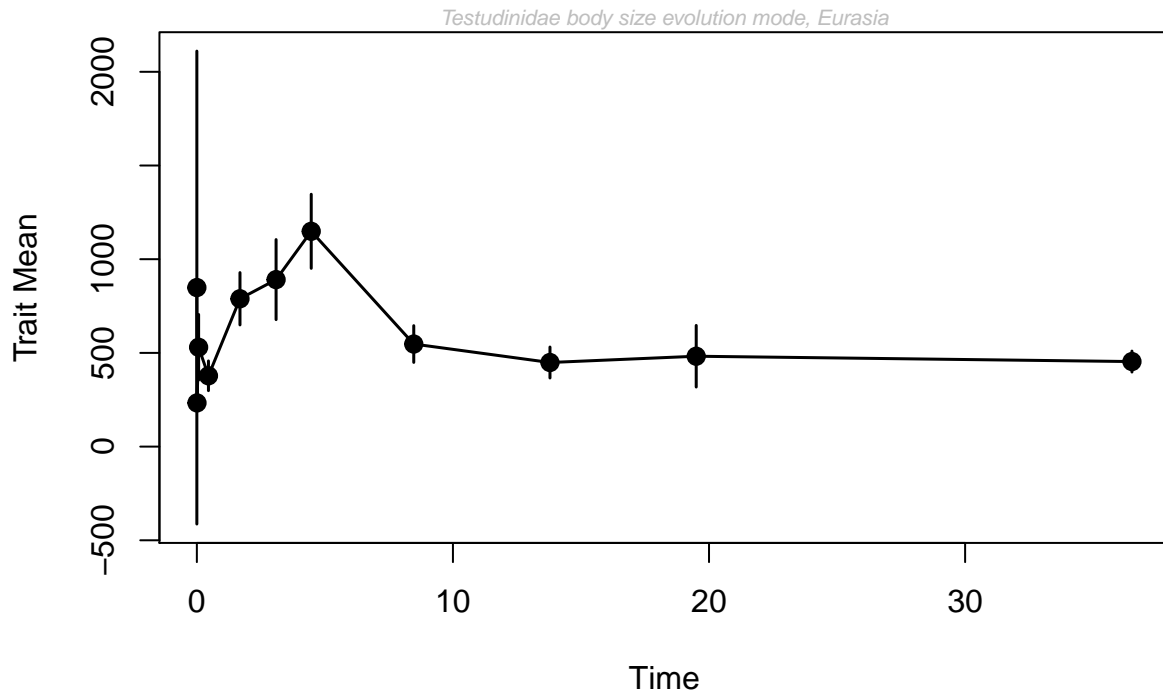|	logL	K	AICc	Akaike.wt
GRW	-105.54806	2	216.8104	0
URW	-105.54484	1	213.5897	0
Stasis	-80.19133	2	166.0969	1

Figure 45: individuals, Eurasia

Table 37: Model-fitting results for testudinidae, individuals, Asia

	logL	K	AICc	Akaike.wt
GRW	-73.15365	2	152.0216	0.083
URW	-73.32855	1	149.1571	0.349
Stasis	-71.23399	2	148.1823	0.568

Table 38: Model-fitting results for testudinidae (4 models), individuals, Asia

	logL	K	AICc	Akaike.wt
GRW	-73.15365	2	152.0216	0.083

	logL	K	AICc	Akaike.wt
URW	-73.32855	1	149.1571	0.349
Stasis	-71.23399	2	148.1823	0.568
StrictStasis	-95.42787	1	193.3557	0.000

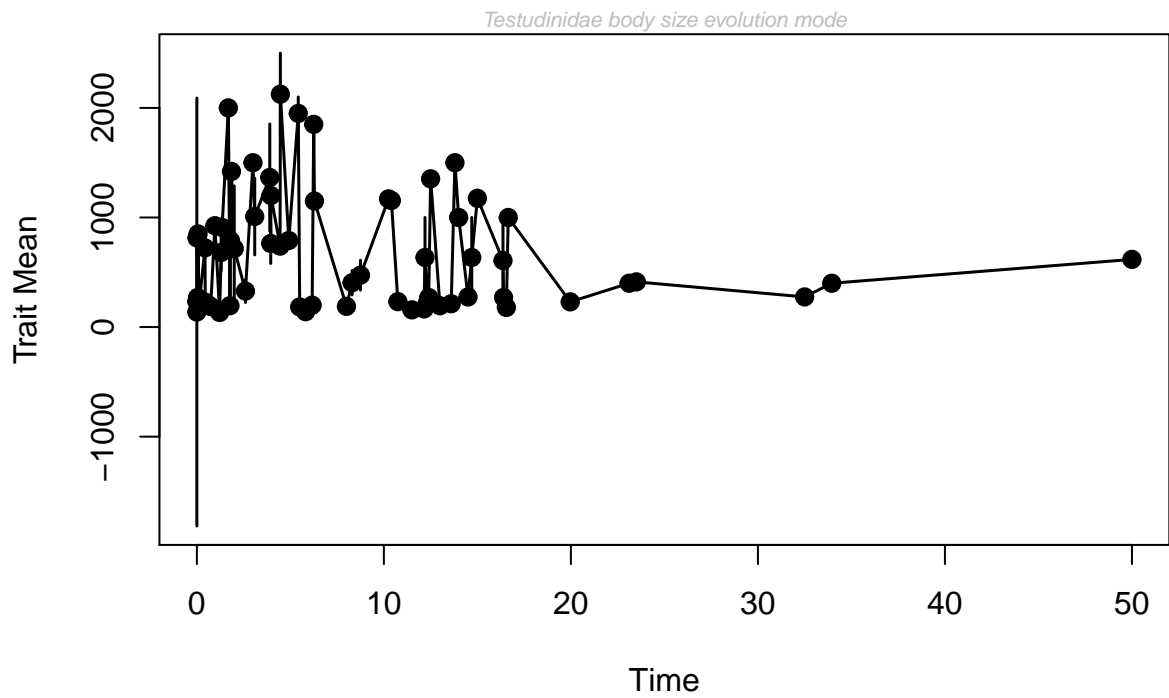*Testudinidae body size evolution mode*

Figure 46: Eurasia, individuals, no bins

Table 39: Model-fitting results for testudinidae, individuals, no bins, Eurasia

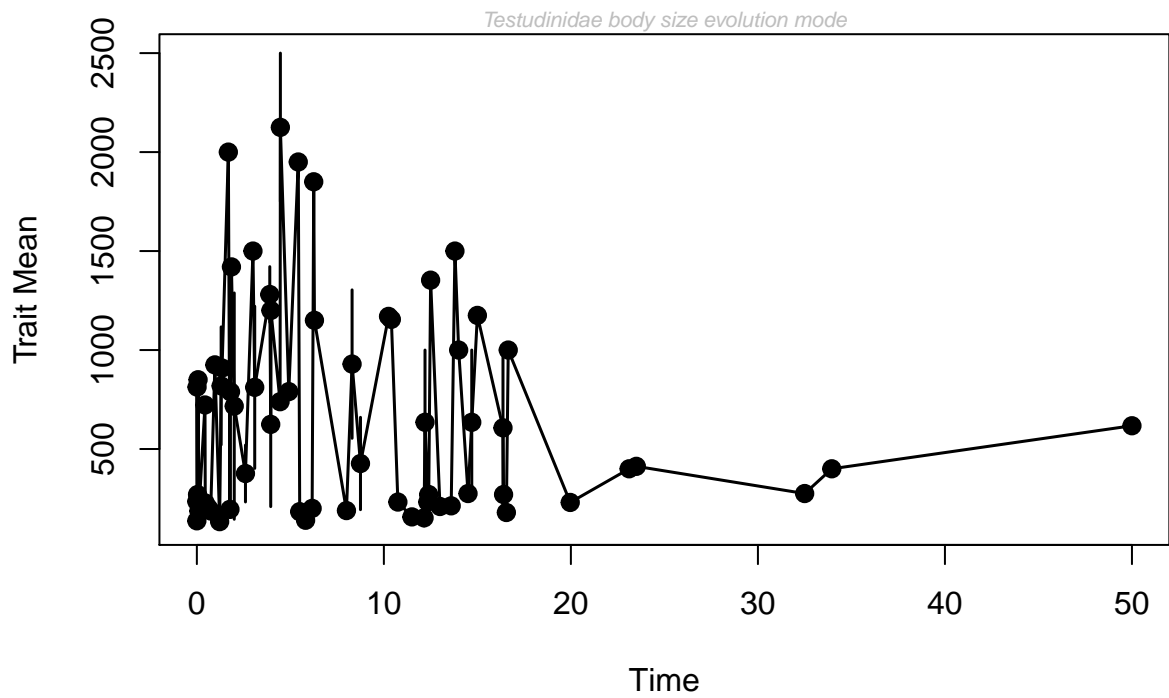|	logL	K	AICc	Akaike.wt
GRW	-1254.0121	2	2512.224	0
URW	-1193.3477	1	2388.761	0
Stasis	-600.6003	2	1205.401	1

Figure 47: Mean age of each sample as time bin, genera, Eurasia

Table 40: Model-fitting results for testudinidae, no bins, genera

	logL	K	AICc	Akaike.wt
GRW	-2350.1503	2	4704.5006	0
URW	-1237.0573	1	2476.1801	0
Stasis	-484.4122	2	973.0243	1