Body size trends in Neogene tortoises

Did tortoises evolve towards a smaller body size?

Julia Joos

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Terrestrial Tortoises

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Rhodin et al. (2015)

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- ≠ Meiolaniidae (Australia, S-America)

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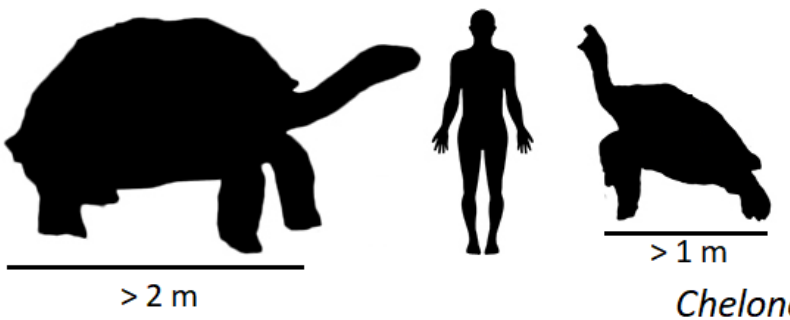
  - → oldest fossils from N-America + Europe (Eocene)
- throughout Earth's history: many large forms

Largest tortoises

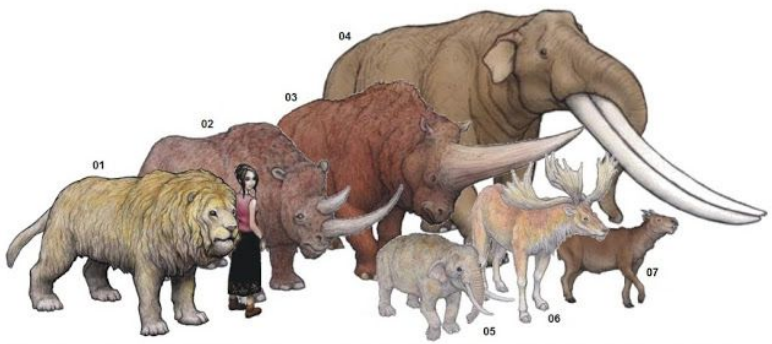
Centrochelys sulcata

Megalochelys atlas



Chelonoidis sp.

Megafauna



Megafauna da Eurásia: leão das cavernas (01 - *Panthera l. spelaea*), rinocerontes peludos (02 - *Coelodonta* e 03 - *Elasmotherium*), elefantes gigantes (04 - *Stegodon*) e anões (05 - *Elephas falconeri*), cervos gigantes (06 - *Sinomegaceros*) e cabrito (07 - *Myotragus*). Assim como na África, a parte continental foi relativamente poupada, mas as ilhas (especialmente as mediterrâneas) foram arrasadas.

- animals with body mass > 44 kg = megafauna

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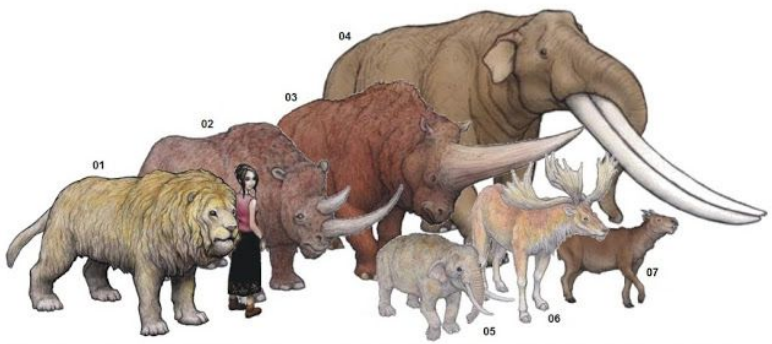

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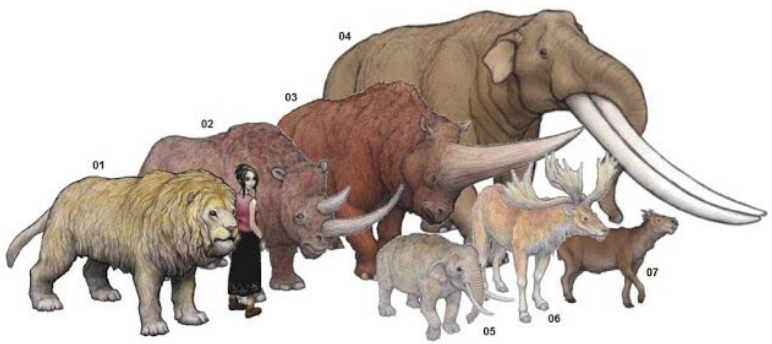

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- megafauna extinctions →humans or climate change?

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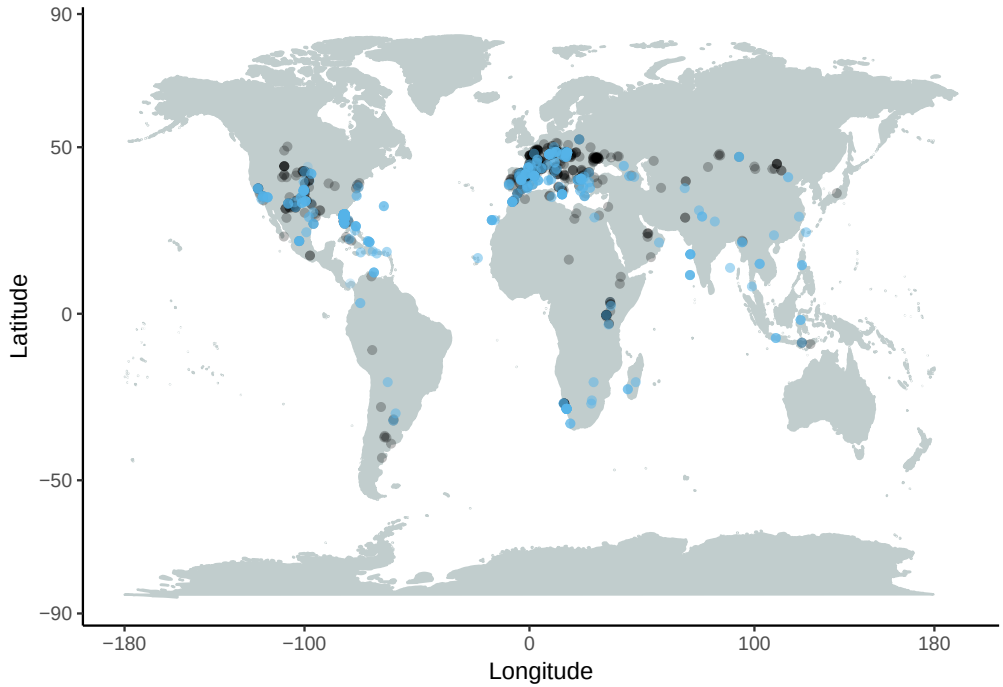
Data set



- occurrences (black): 796 individuals, 647 localitis (Eocene - recent)

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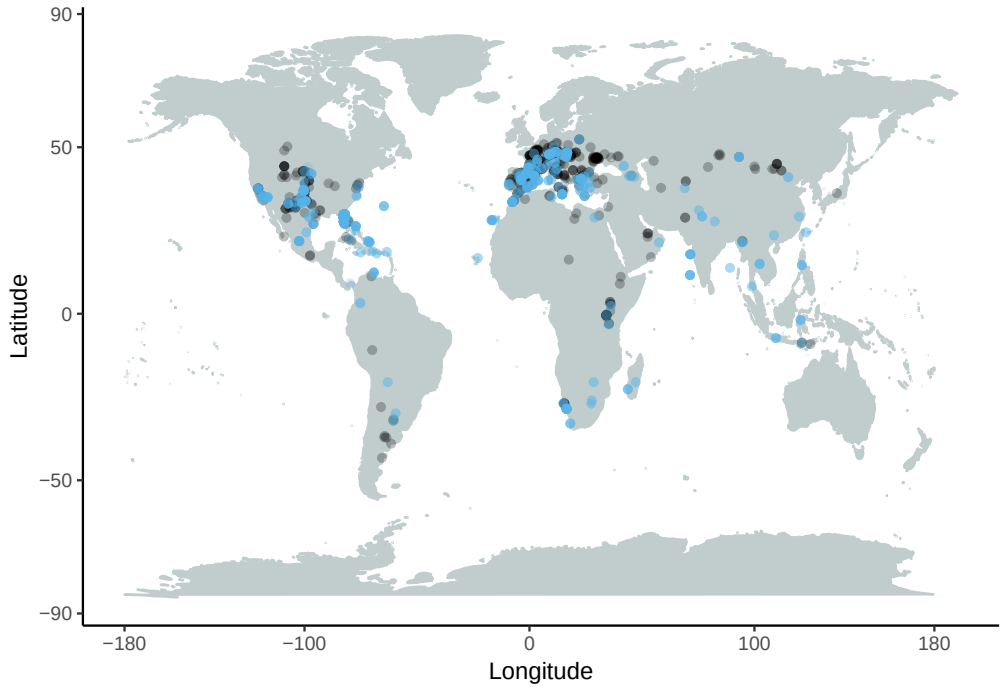

- occurrences (black): 796 individuals, 647 localitis (Eocene - recent)
- body size data (blue): 376 individuals, 193 localities (Miocene - recent) (106 loc in FFB)

Carapace length measurements/estimations

Straight carapace length [mm]

Carapace length measurements/estimations

exact measurements
(literature)

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CL estimations
- plastron length
- femora/humeri lengths

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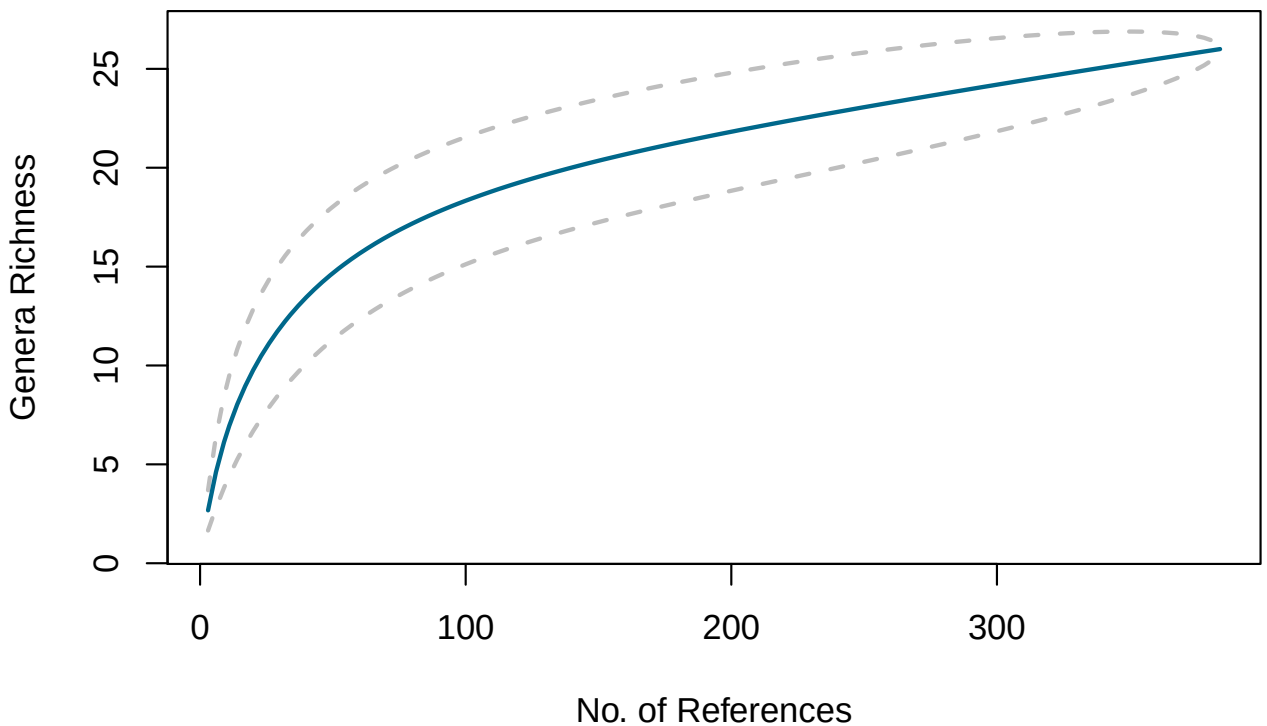

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- paleoTS: fit different models to evolutionary trajectory of testudinid body size

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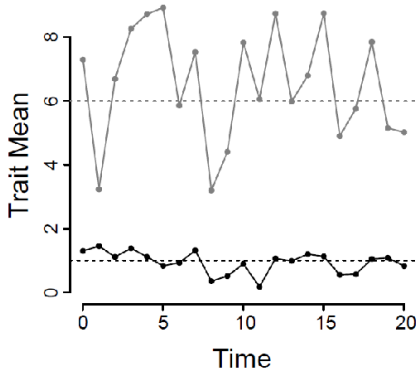

Stasis (change fluctuates around mean)
net change = 0

Hunt & Carrano, 2010

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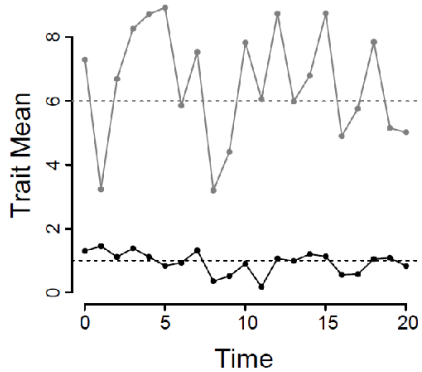

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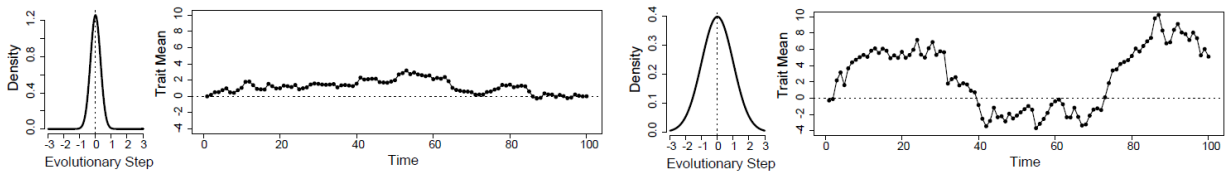
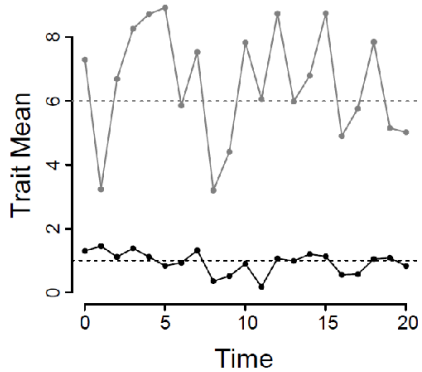


URW (unbiased random walk = non-directional change

Hunt & Carrano, 2010



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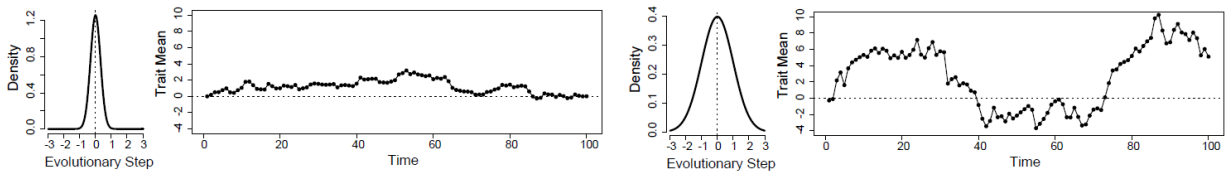

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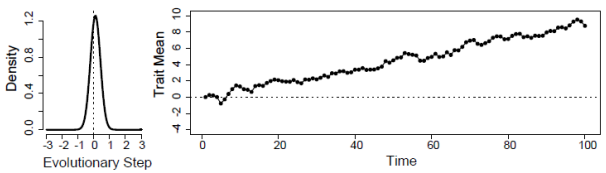

GRW (generalized random walk) = direcitonal change

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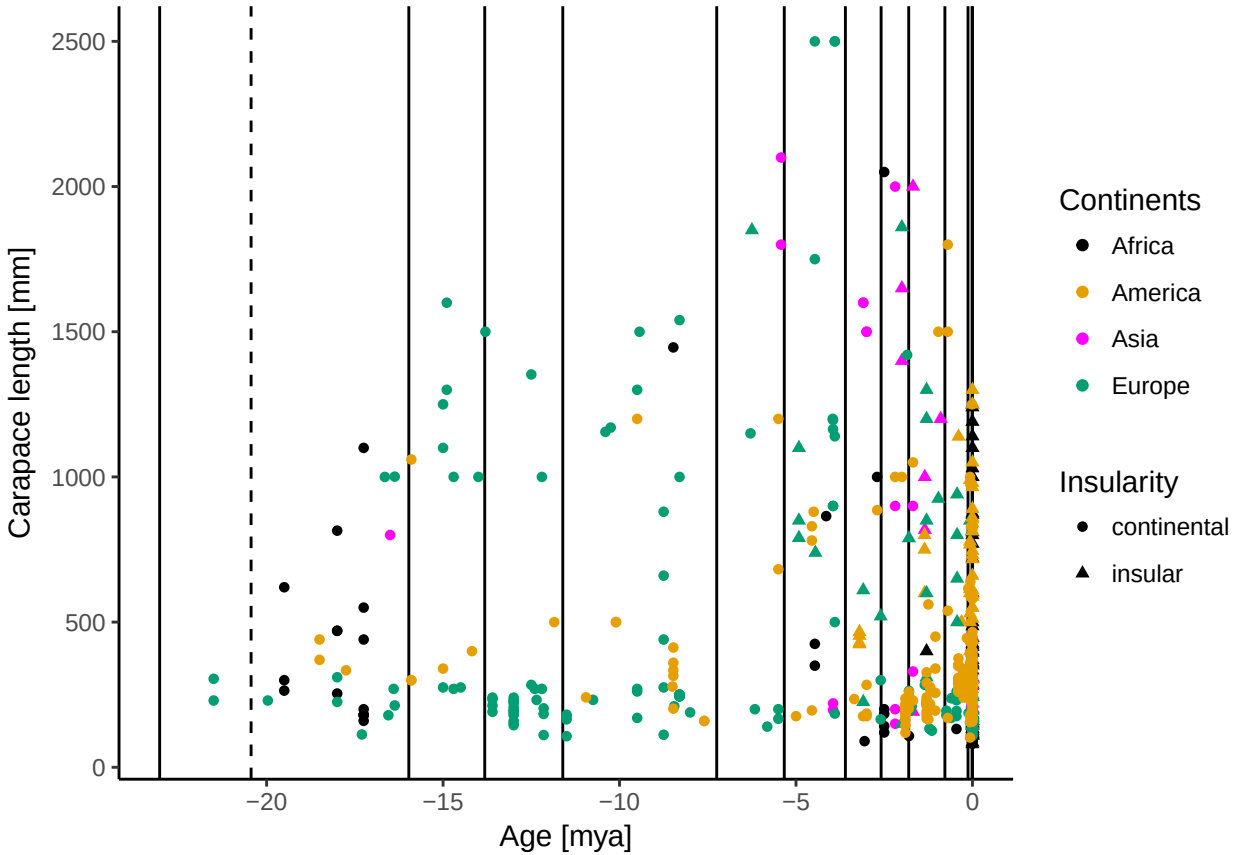

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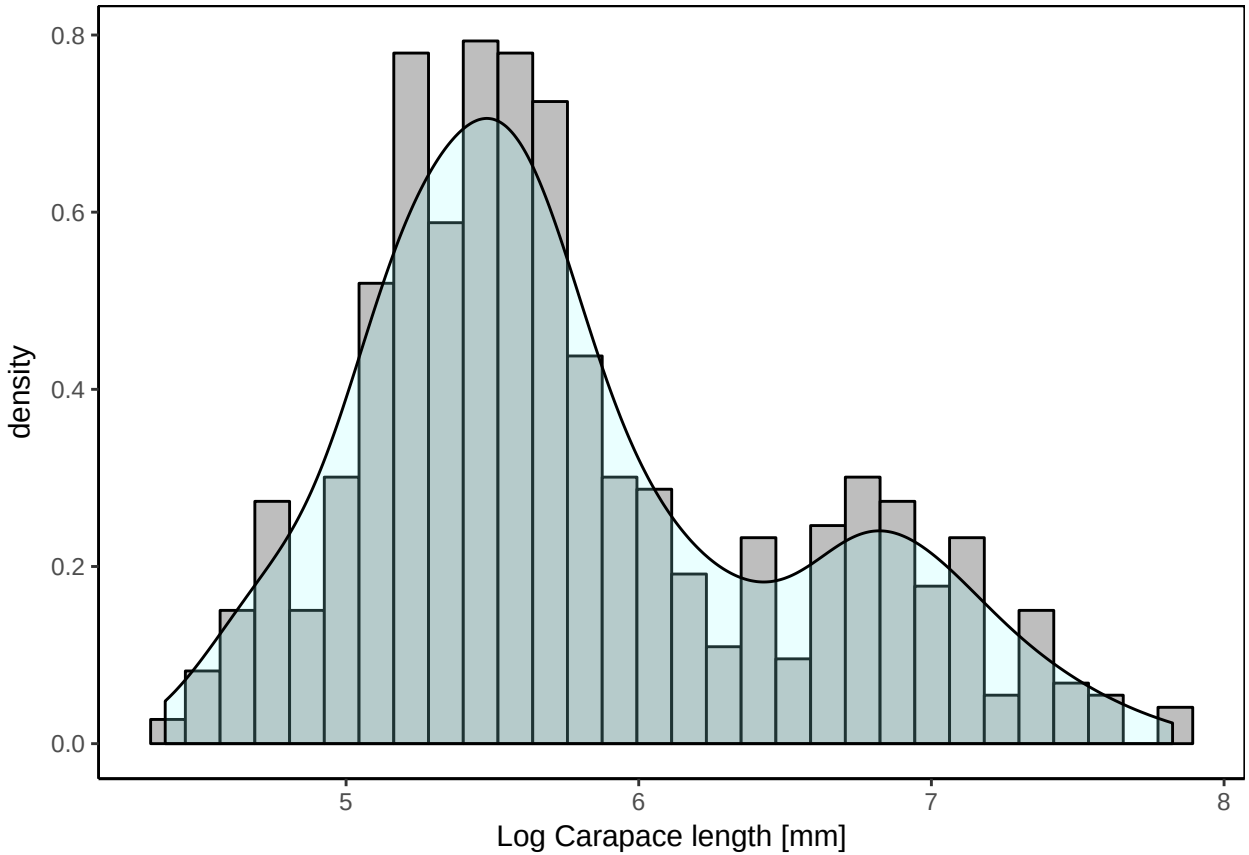
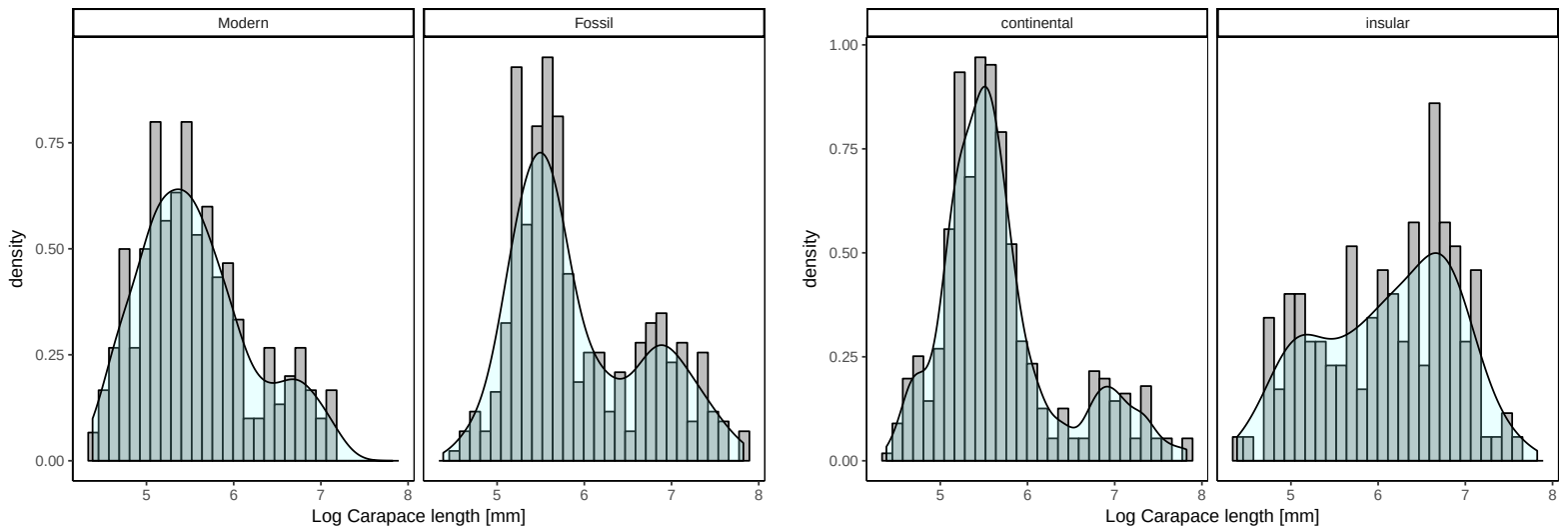
Body size distribution – complete data set

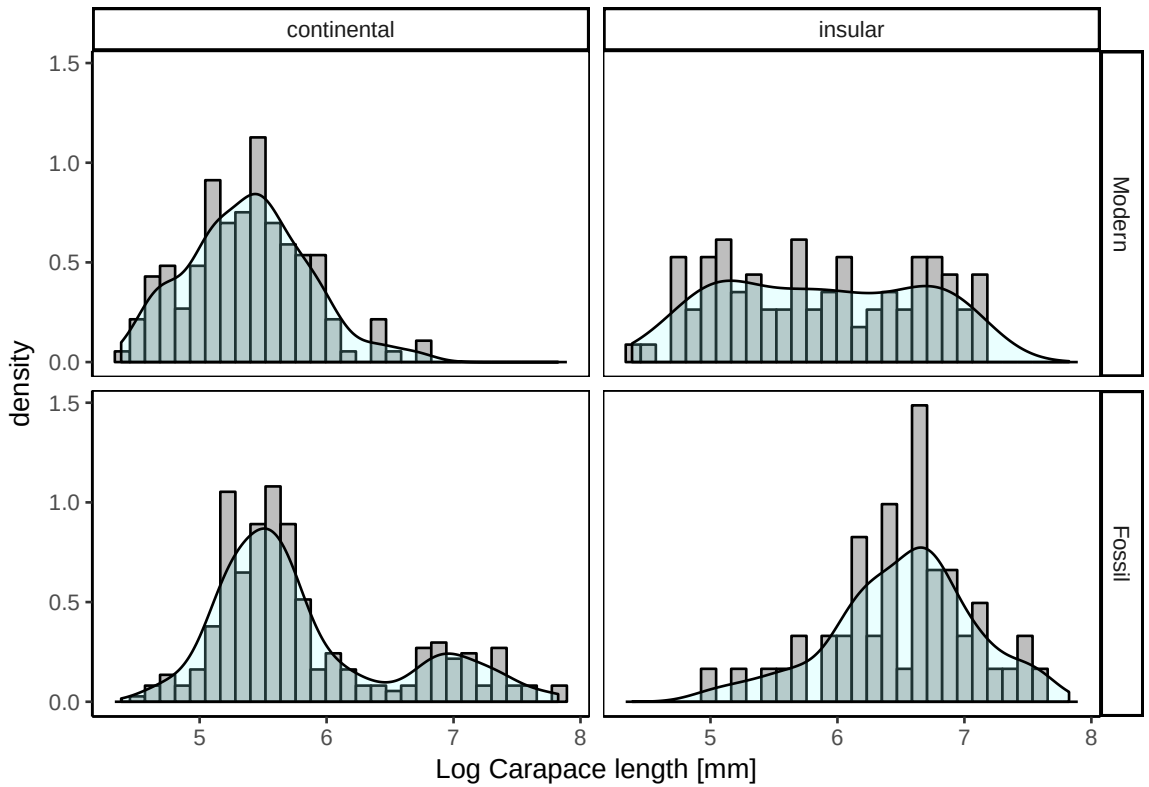


- bimodal distribution - right-skewed: small body sizes are more frequent

Body size distribution – subsets



- islands: higher abundance of larger-bodied tortoises (left-skewed)



- modern continentals: no large taxa!

- right-skewed body size distributions frequent in animal record: smaller animals usually more abundant - WHY? (competition, take up less space, need fewer resources, shorter generation times etc.)
- left-skewed on islands: island rule? (has been found for turtles in other studies →Angielzcyk + Jaffe??)
- relatively constant through time

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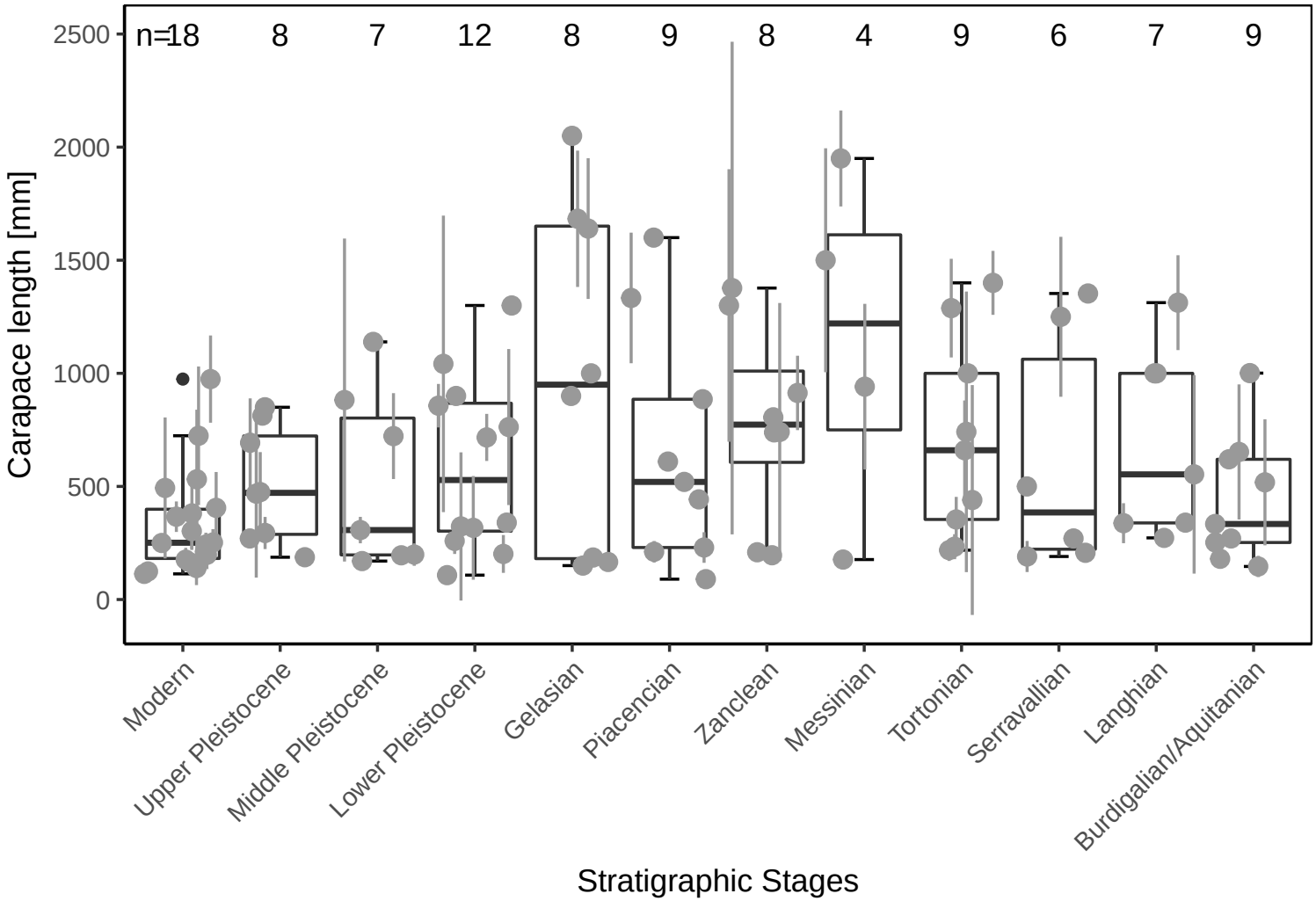
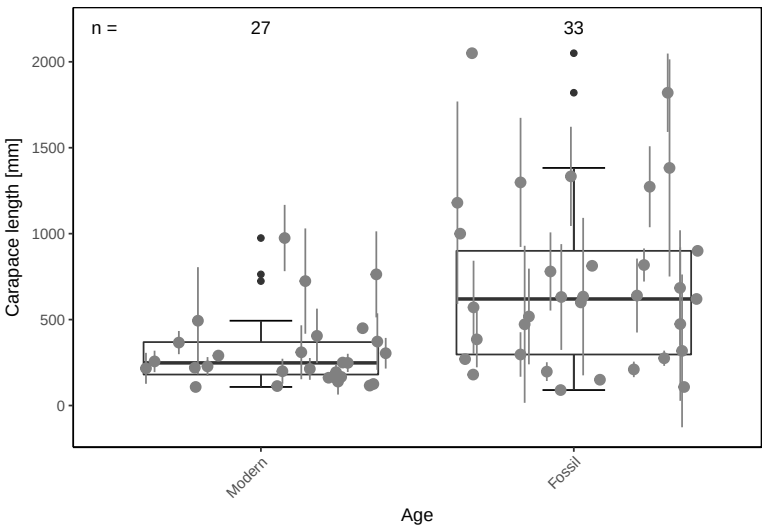
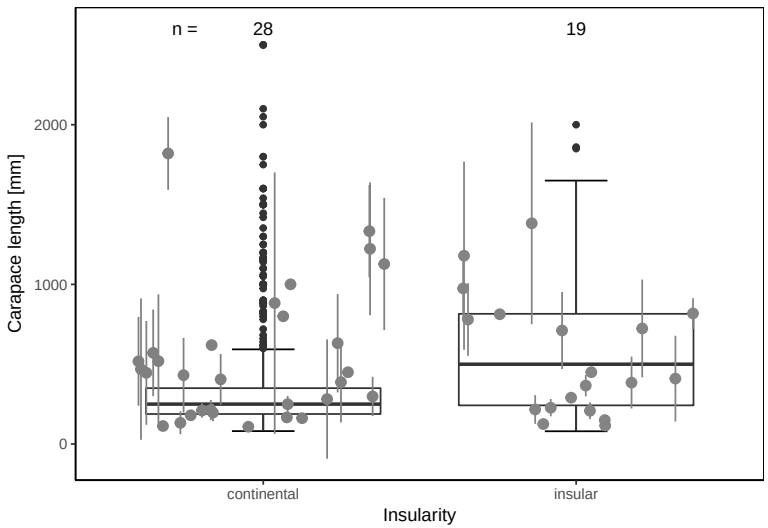
Comparison across time bins

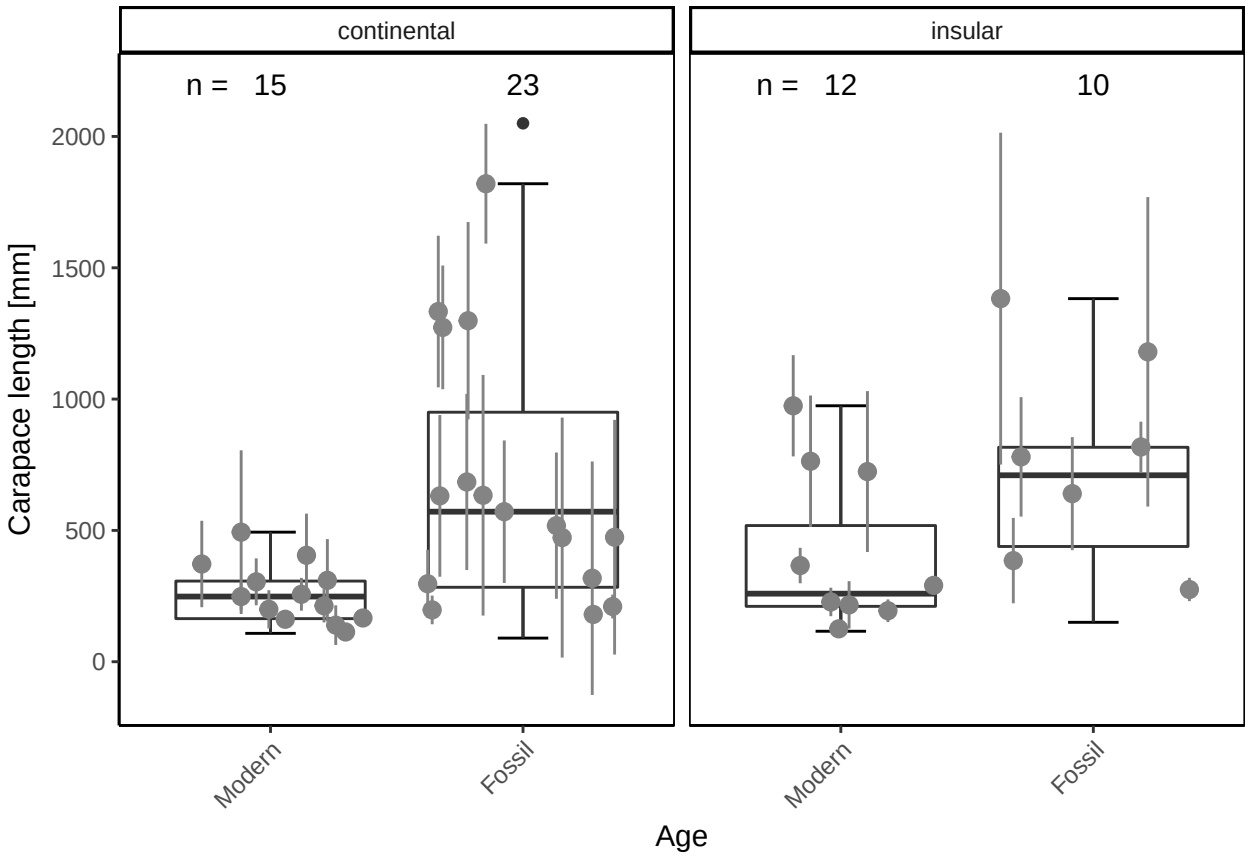


- only significant differences: Modern < Upper Pleistocene,

Modern < fossil, continental < insular






continental
insular
n = 15
23
n = 12
10
2000
1500
1000
500
0
Carapace length [mm]
Modern
Fossil
Modern
Fossil
Age

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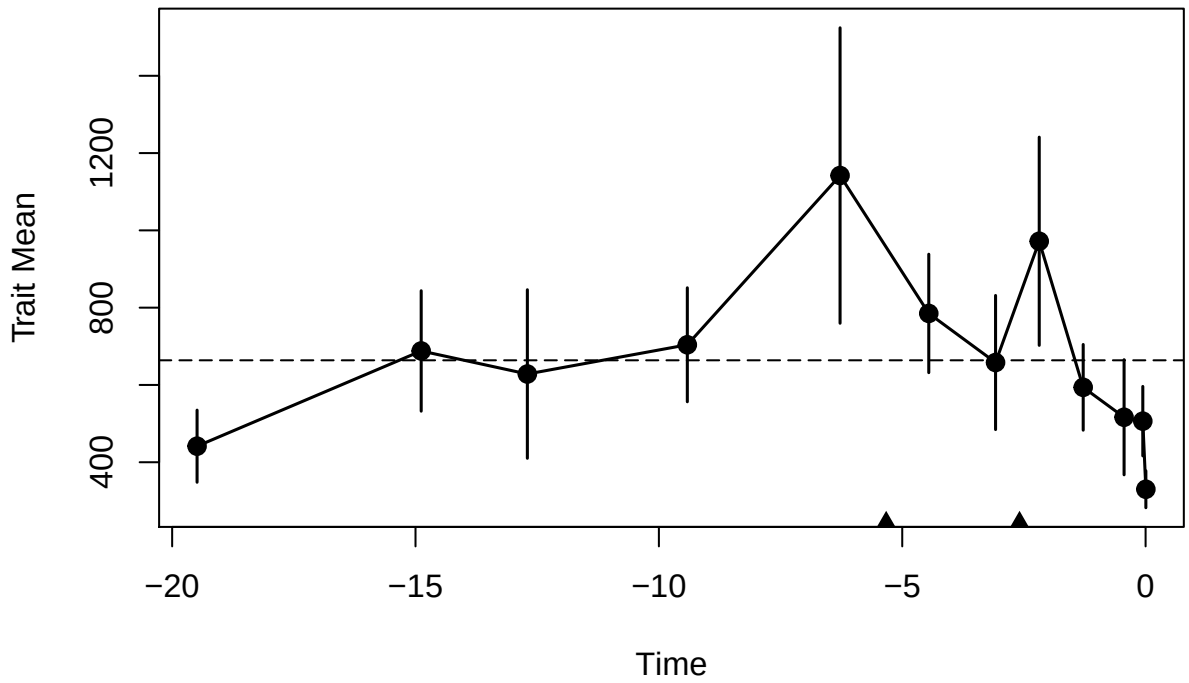
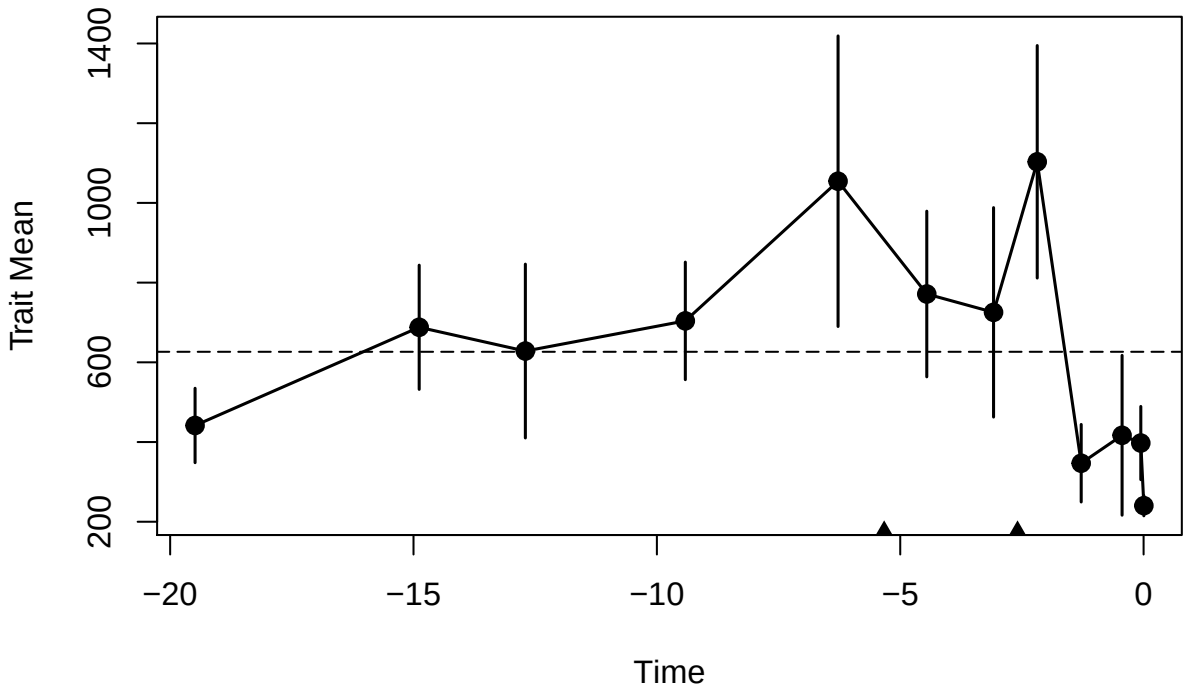
Time-scale analysis



complete dataset →stasis



continental dataset →unbiased random walk (URW)

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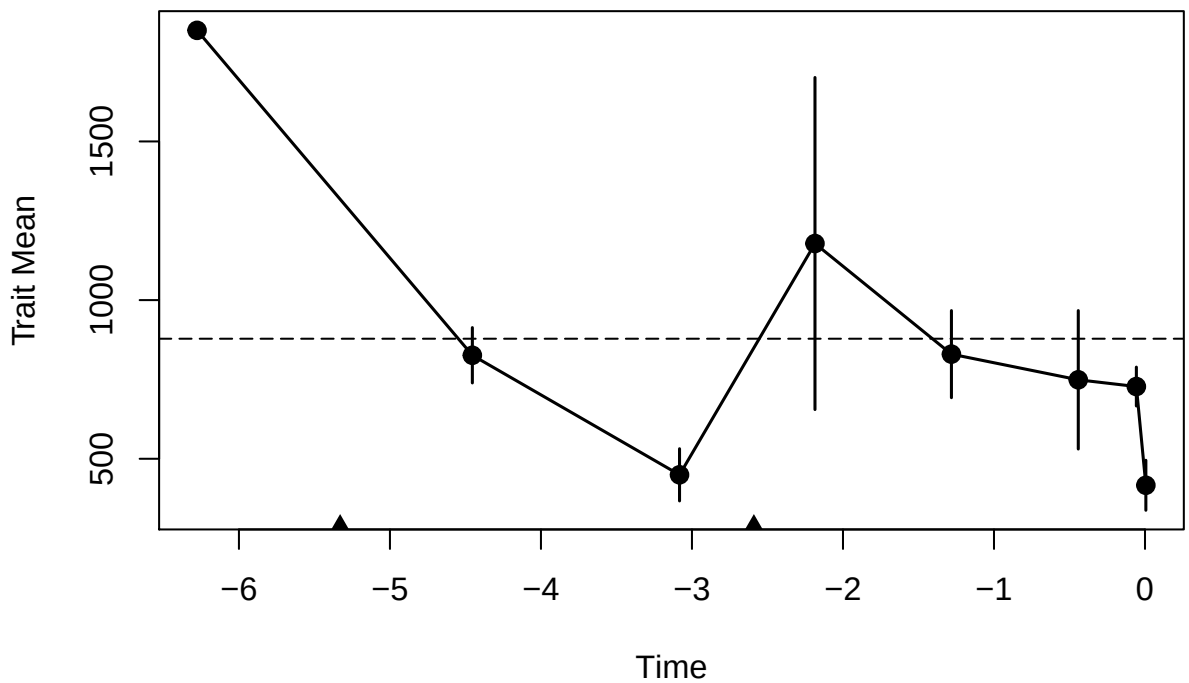
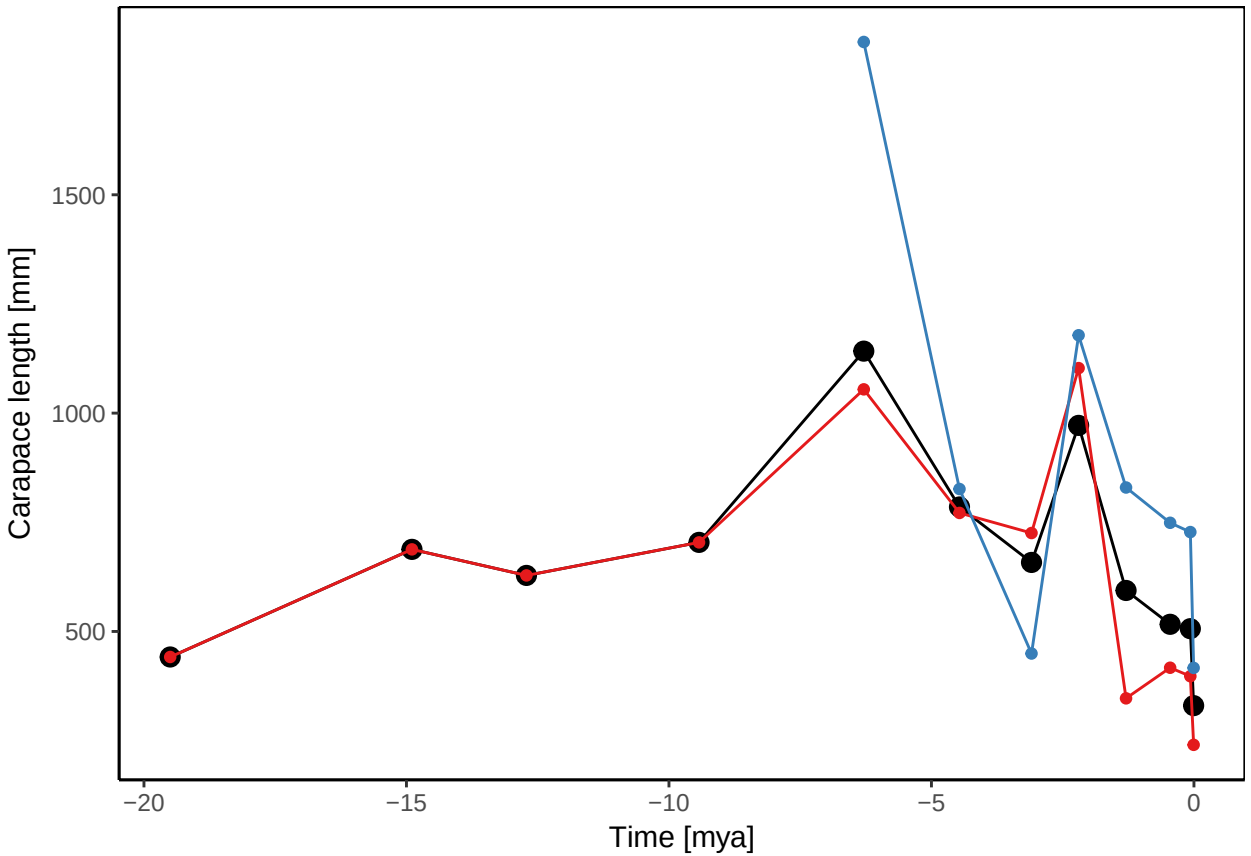


insular dataset →stasis

Time-scale analysis



black: complete dataset (stasis), red: continental (URW), blue: insular (stasis)

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- non-directional change on continents →size-biased extinction (giant tortoises)

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- climatic influence
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  - run risk ov overheating (e. g. Aldabra Atoll: overheating main reason for death)

Thank you!