Body size trends in Neogene tortoises

30.05.2017

TO DO:

- figure out if Checklist data is of any use (means? medians? sample size?) or see if authors can provide necessary data
- do paleoTS analyses with FFB data set
- read Hunt papers (see citations in Catalina's paper 2006, 2008, 2008, 2010; also 2015)
- figure out how to implement phylogeny... well, figure out how to do paleoTS analyses with more than one taxon without pooling everything together (as in Test2)

06.06.2017

```
tidyCL<-read.csv("tortoises_tidy.csv", sep=";", header=TRUE)


colnames(tidyCL)[6] <- "MAmin"
colnames(tidyCL)[7] <- "Mamax"
colnames(tidyCL)[17] <- "CL"
colnames(tidyCL)[18] <- "PL"


statsCL <- tidyCL %>%
  dplyr::filter(!is.na(CL)) %>%
  summarise(min = min(CL), max = max(CL), var(CL), mean= mean(CL), median= median(CL))#, skew(CL), kurt

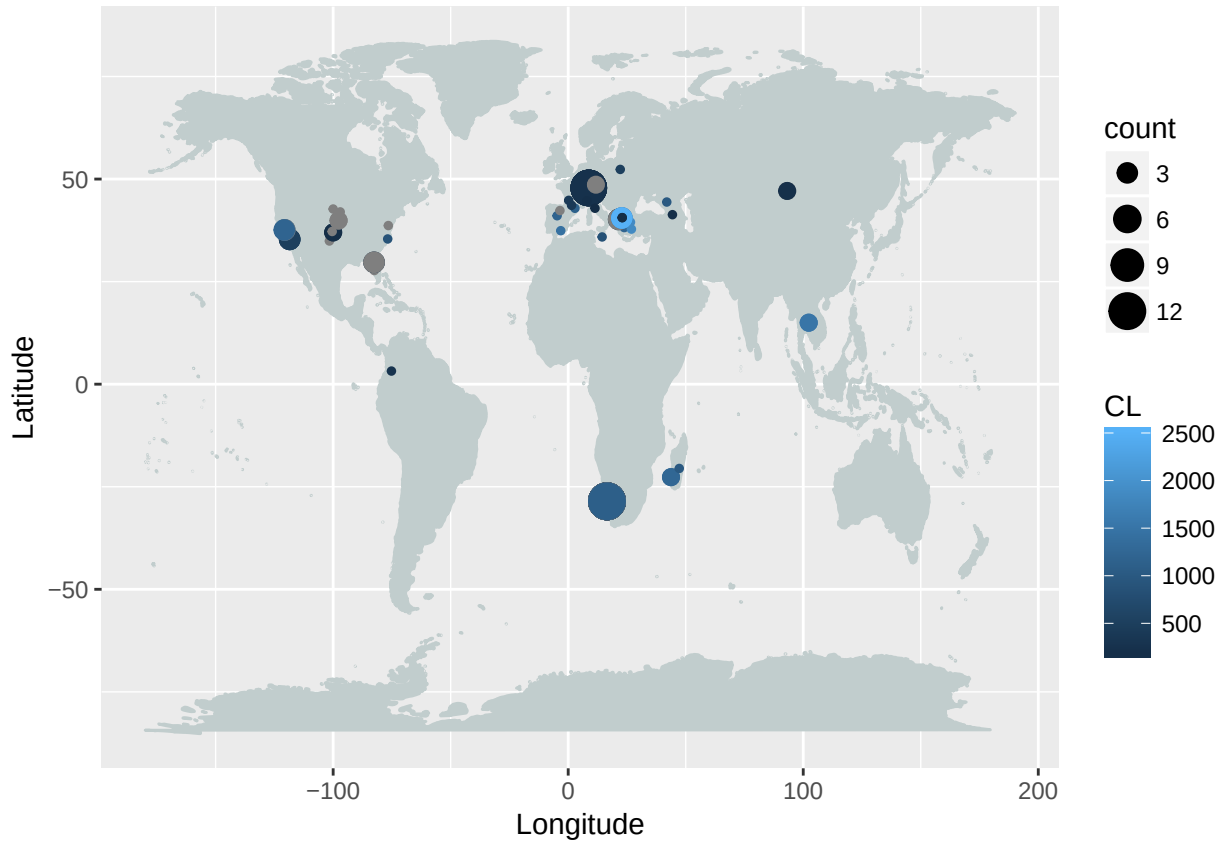


Map <- tidyCL %>%
  dplyr::select(Genus, Taxon, Latitude, Longitude, Country, CL, PL) %>%
  group_by(Latitude) %>%
  mutate(count= n())

mapWorld <- borders("world", colour="azure3", fill="azure3") # create a layer of borders


mp <- Map %>%
  ggplot(aes(Longitude, Latitude)) + mapWorld +
#  geom_point(fill="red", colour="red", size=0.5) +
  geom_point(aes(Longitude, Latitude,colour=CL, size=count))

mp
```




```
library(plotly)
```

```
##
## Attaching package: 'plotly'
```

```
## The following object is masked from 'package:ggplot2':
##
##     last_plot
```

```
## The following object is masked from 'package:stats':
##
##     filter
```

```
## The following object is masked from 'package:graphics':
##
##     layout
```

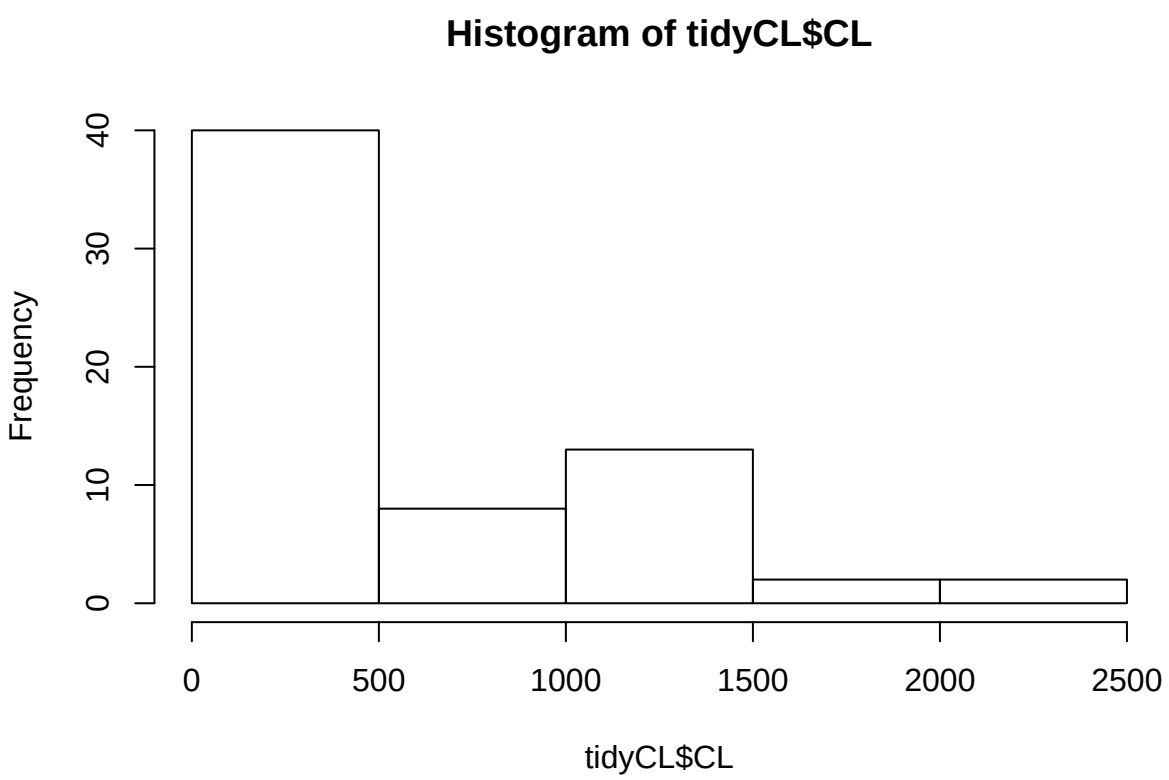
```
ggplotly(mp)
```

```
## We recommend that you use the dev version of ggplot2 with `ggplotly()`
## Install it with: `devtools::install_github('hadley/ggplot2')`
```

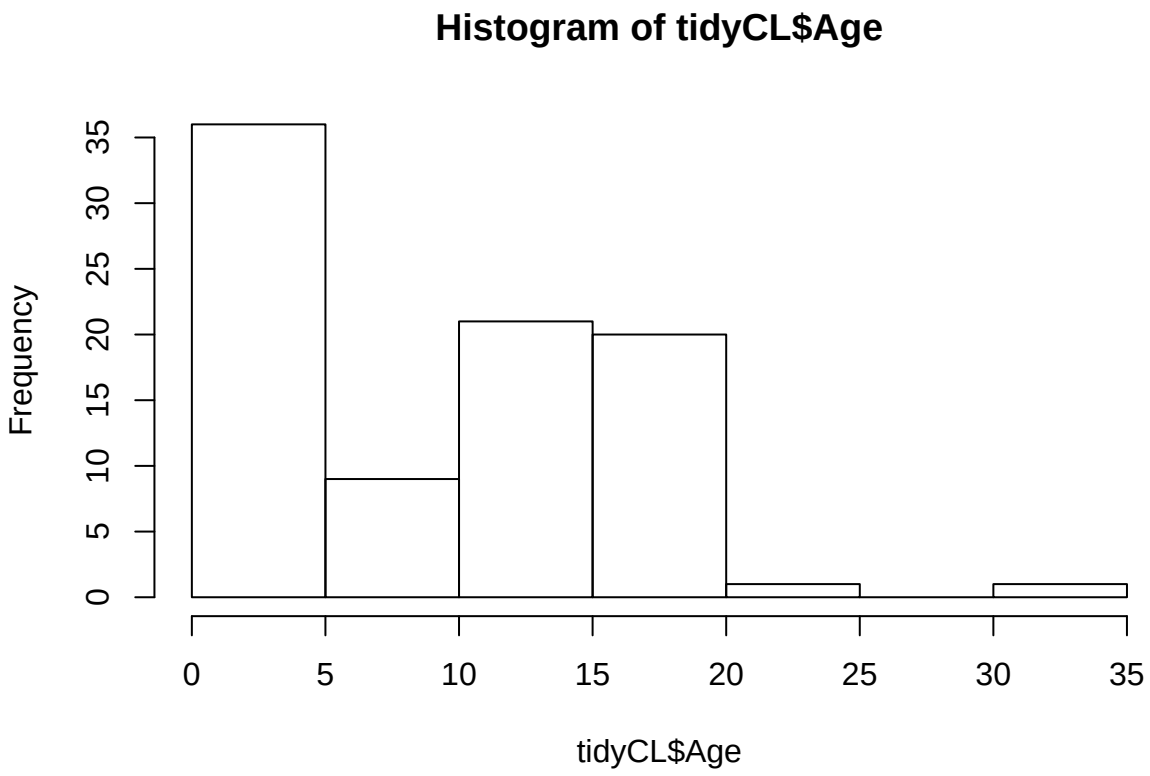
Get an overview over body size data

```
tidyCL <-  tidyCL %>%
  mutate(Age= (MAmin+Mamax)/2)

hist(tidyCL$CL)
```




```
hist(tidyCL$Age)
```



TO DO:

- map localities with differing colors for: CL available, CL extrapolated (from PL or figures), CL missing
- complete data set!
- get missing refences/make list of missing references

08.06.17

Map all localities with sample size and age indicated (regardless of whether CL information is available):

```
test<-read.csv("tortoises13-04.csv", sep=";", header=TRUE)

colnames(test)[6] <- "Mamin"
colnames(test)[7] <- "Mamax"

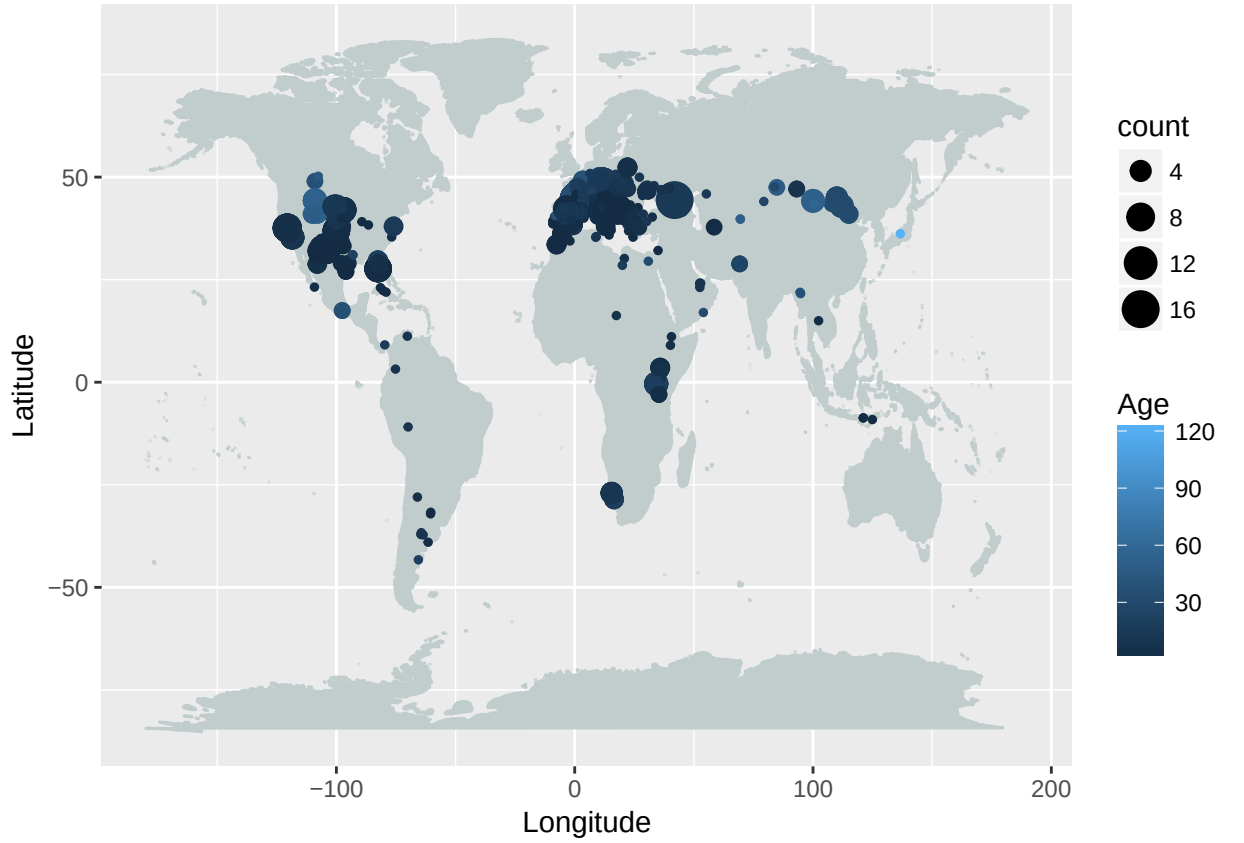
Test <- test %>%
  dplyr::select(Locality, Country, Latitude, Longitude, Mamin, Mamax, Epoch, Genus, Species, Taxon, CL)
  mutate(Age= (Mamin+Mamax)/2) %>%   # create mean age
  group_by(Latitude) %>%
  mutate(count= n())

#mapWorld <- borders("world", colour="azure3", fill="azure3") # create a layer of borders

map <- Test %>%
```

```
  ggplot(aes(Longitude, Latitude)) + mapWorld +
  #geom_point(fill="red", colour="red", size=0.5) +
  geom_point(aes(Longitude, Latitude,colour=Age, size=count))

map
```




```
ggplotly(map)
```

```
## We recommend that you use the dev version of ggplot2 with `ggplotly()`
## Install it with: `devtools::install_github('hadley/ggplot2')`
```

TO DO:

- get general statistical overview over data (stru, normal distribution?, mean/mode/median/min/max, hist plot etc. –> see Catalina's paper)

Try paleoTS with some first real data. Here is the underlying data:

```
tidyCL
```

```
##                                                    Locality
## 1                                San Nicolas, UCMP locality V4536
## 2              Serrat-d´en-Vacquer near Perpignan, Pyrénées-Orientales
## 3           Toulouse Puits Borderouge niveau inférieur, Haute-Garonne
## 4                          Baby 2, Saint-André-et-Appelles, Gironde
## 5                                                          Dmanisi
## 6                                  Altenstadt, 7 km S Illertissen
```

```
## 7                                                        Gammelsdorf
## 8                                                        Gammelsdorf
## 9                          Hohenhöwen, Engen, Hegau, southwestern Germany
## 10                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 11                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 12                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 13                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 14                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 15                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 16                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 17                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 18                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 19                         Hohenhöwen, Engen, Hegau, southwestern Germany
## 20                                              Kirchdorf an der Iller
## 21                                                      Sandelzhausen
## 22                                 Sandelzhausen unterer Geröllmergel (B)
## 23                                               Steinheim a. Albuch
## 24                                                 Liossati, Kiourka
## 25                                                          Samos 1
## 26                                              Lesbos Island, F-Site
## 27                                          Milia, Grevena, W Macedonia
## 28                                          Milia, Grevena, W Macedonia
## 29                                          Milia, Grevena, W Macedonia
## 30      Nea Kallikratia, western Chalkidiki Peninsula, Thessaloniki area
## 31      Epanomi (EPN I), western Chalkidiki Peninsula, Thessaloniki area
## 32     Epanomi (EPN II), western Chalkidiki Peninsula, Thessaloniki area
## 33       Nea Michaniona, western Chalkidiki Peninsula, Thessaloniki area
## 34                          Megalo Emvolon 1 (MEV), 20 km SW Thessaloniki
## 35                          Megalo Emvolon 1 (MEV), 20 km SW Thessaloniki
## 36                          Megalo Emvolon 1 (MEV), 20 km SW Thessaloniki
## 37  Allatini, eastern part of Thessaloniki, western Chalkidiki peninsula
## 38     Pylea, eastern part of Thessaloniki, western Chalkidiki peninsula
## 39                                       Torrente Melacce, Cinigiano (GR)
## 40                                               Santa-Vittoria d'Alba
## 41                                                             Etseré
## 42                                                             Etseré
## 43                                                          Ambositra
## 44                                    Zebbug and Gahr Dalam Cave deposits
## 45                      Altan-Teli main fossiliferous bed (Dzereg valley)
## 46                      Altan-Teli main fossiliferous bed (Dzereg valley)
## 47            Elisabethfeld (= Elisabeth Bay) area, northern Sperrgebiet
## 48            Elisabethfeld (= Elisabeth Bay) area, northern Sperrgebiet
## 49                                                             Auchas
## 50                                                             Auchas
## 51                                                             Auchas
## 52                                                             Auchas
## 53                                                          Arrisdrift
## 54                                                          Arrisdrift
## 55                                                          Arrisdrift
## 56                                                          Arrisdrift
## 57                                                          Arrisdrift
## 58                                                          Arrisdrift
## 59                                                          Arrisdrift
## 60                                                          Arrisdrift
```

```
## 61                                                                    W??e 1
## 62                                                                Belomechetskaya
## 63                                                  Fonelas P-1, Guadix Basin
## 64                                  El Lugarejo (Arévalo), Ávilla, Castilla
## 65                       Sima del Elefante TE14, Sierra de Atapuerca, Burgos
## 66 Tha Chang area, Chaloem Pra Kiat district, Nakhon Ratchasima Province
## 67 Tha Chang area, Chaloem Pra Kiat district, Nakhon Ratchasima Province
## 68                         Leisey Shell Pit 1A, Hillsborough County, Florida
## 69                                  Arredondo IIA, Alachua County, Florida
## 70                       McGehee Farm near Newberry, Alachua County, Florida
## 71                        Thomas Farm Local Fauna, Gilchrist County, Florida
## 72                        Thomas Farm Local Fauna, Gilchrist County, Florida
## 73                 North Cita Canyon (Middle Stratum), Randall County, Texas
## 74                 Iron Canyon Fauna, Mojave Desert, Kern County, California
## 75                     Ricardo Fauna, Mojave Desert, Kern County, California
## 76                     Ricardo Fauna, Mojave Desert, Kern County, California
## 77         Lee Creek Mine, Yorktown Sample, Beaufort County, North Carolina
## 78                        Sawrock Canyon local fauna, Seward County, Kansas
## 79                        Sawrock Canyon local fauna, Seward County, Kansas
## 80                          Cragin Quarry Local Fauna, Meade County, Kansas
## 81              UCMP V71137, Turlock Lake 10, Stanislaus County, California
## 82              UCMP V81248, Turlock Lake 11, Stanislaus County, California
## 83          UCMP V-3952, Ingram Creek site 8, Stanislaus County, California
## 84                                  Randle Cliff, Calvert County, Maryland
## 85                           White Rock local fauna, Republic County, Kansas
## 86                           White Rock local fauna, Republic County, Kansas
## 87                                        Santee, Knox County, Nebraska
## 88                             Sand Draw local fauna, Brown County, Nebraska
##       Country Latitude Longitude
## 1    Colombia   3.2000  -75.2000
## 2      France  42.8800    2.8800
## 3      France  43.6000    1.4333
## 4      France  44.8120    0.2133
## 5     Georgia  41.3200   44.3500
## 6     Germany  48.1542   10.1178
## 7     Germany  48.5495   11.9382
## 8     Germany  48.5495   11.9382
## 9     Germany  47.8356    8.7490
## 10    Germany  47.8356    8.7490
## 11    Germany  47.8356    8.7490
## 12    Germany  47.8356    8.7490
## 13    Germany  47.8356    8.7490
## 14    Germany  47.8356    8.7490
## 15    Germany  47.8356    8.7490
## 16    Germany  47.8356    8.7490
## 17    Germany  47.8356    8.7490
## 18    Germany  47.8356    8.7490
## 19    Germany  47.8356    8.7490
## 20    Germany  48.0728   10.1424
## 21    Germany  48.6283   11.7960
## 22    Germany  48.6283   11.7960
## 23    Germany  48.6939   10.0678
## 24     Greece  38.1692   23.8434
## 25     Greece  37.8000   26.9000
```

```
## 26     Greece  39.5000   26.5000
## 27     Greece  40.1791   21.4756
## 28     Greece  40.1791   21.4756
## 29     Greece  40.1791   21.4756
## 30     Greece  40.3146   23.0462
## 31     Greece  40.4046   22.8980
## 32     Greece  40.4046   22.8980
## 33     Greece  40.4731   22.8385
## 34     Greece  40.5017   22.8177
## 35     Greece  40.5017   22.8177
## 36     Greece  40.5017   22.8177
## 37     Greece  40.5899   22.9716
## 38     Greece  40.5994   22.9876
## 39      Italy  42.8833   11.4000
## 40      Italy  44.7000    7.9333
## 41 Madagascar -22.6615   43.7313
## 42 Madagascar -22.6615   43.7313
## 43 Madagascar -20.5394   47.2472
## 44      Malta  35.8897   14.4425
## 45   Mongolia  47.1000   93.1667
## 46   Mongolia  47.1000   93.1667
## 47    Namibia -26.9161   15.1838
## 48    Namibia -26.9161   15.1838
## 49    Namibia -28.5500   16.5000
## 50    Namibia -28.5500   16.5000
## 51    Namibia -28.5500   16.5000
## 52    Namibia -28.5500   16.5000
## 53    Namibia -28.5500   16.5000
## 54    Namibia -28.5500   16.5000
## 55    Namibia -28.5500   16.5000
## 56    Namibia -28.5500   16.5000
## 57    Namibia -28.5500   16.5000
## 58    Namibia -28.5500   16.5000
## 59    Namibia -28.5500   16.5000
## 60    Namibia -28.5500   16.5000
## 61     Poland  52.3500   22.1500
## 62     Russia  44.4000   41.9333
## 63      Spain  37.4170   -3.1670
## 64      Spain  41.0560   -4.7169
## 65      Spain  42.3300   -3.5100
## 66   Thailand  14.9874  102.3352
## 67   Thailand  14.9874  102.3352
## 68        USA  27.7000  -82.5000
## 69        USA  29.6000  -82.4000
## 70        USA  29.7000  -82.6000
## 71        USA  29.7000  -82.6000
## 72        USA  29.7000  -82.6000
## 73        USA  34.9000 -101.6000
## 74        USA  35.3000 -118.5000
## 75        USA  35.3000 -118.5000
## 76        USA  35.3000 -118.5000
## 77        USA  35.4000  -76.8000
## 78        USA  37.0000 -100.0000
## 79        USA  37.0000 -100.0000
```

```
## 80        USA  37.2242 -100.4176
## 81        USA  37.6000 -120.6000
## 82        USA  37.6000 -120.6000
## 83        USA  37.6000 -120.8000
## 84        USA  38.6665  -76.5298
## 85        USA  39.9000  -97.7000
## 86        USA  39.9000  -97.7000
## 87        USA  42.0000  -97.0000
## 88        USA  42.7000 -100.0000
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## 71 a sinkhole lake that then collapsed into a larger underground chamber earliest Hemmingfordian Nor
## 72 a sinkhole lake that then collapsed into a larger underground chamber earliest Hemmingfordian Nor
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##       MAmin    Mamax               Epoch        upper.stage
## 1   6.00000 11.00000             Miocene          Messinian
## 2   3.60000  4.20000            Pliocene           Zanclean
## 3  23.03000 23.20000           Oligocene           Chattian
## 4  33.90000 34.00000              Eocene         Priabonian
## 5   1.77000  1.77000         Pleistocene  Lower Pleistocene
## 6  11.60000 12.70000             Miocene       Serravallian
## 7  11.60000 12.70000             Miocene       Serravallian
## 8  11.60000 12.70000             Miocene       Serravallian
## 9  13.00000 13.00000             Miocene       Serravallian
```

```
## 10 13.00000 13.00000              Miocene       Serravallian
## 11 13.00000 13.00000              Miocene       Serravallian
## 12 13.00000 13.00000              Miocene       Serravallian
## 13 13.00000 13.00000              Miocene       Serravallian
## 14 13.00000 13.00000              Miocene       Serravallian
## 15 13.00000 13.00000              Miocene       Serravallian
## 16 13.00000 13.00000              Miocene       Serravallian
## 17 13.00000 13.00000              Miocene       Serravallian
## 18 13.00000 13.00000              Miocene       Serravallian
## 19 13.00000 13.00000              Miocene       Serravallian
## 20 16.50000 16.80000              Miocene        Burdigalian
## 21 16.27000 16.47000              Miocene        Burdigalian
## 22 16.27000 16.47000              Miocene        Burdigalian
## 23 12.50000 13.50000              Miocene       Serravallian
## 24  2.58800  5.33200             Pliocene           Pliocene
## 25  5.30000  7.20000              Miocene          Messinian
## 26  2.00000  2.00000          Pleistocene           Gelasian
## 27  2.60000  2.60000             Pliocene         Piacencian
## 28  2.60000  2.60000             Pliocene         Piacencian
## 29  2.60000  2.60000             Pliocene         Piacencian
## 30  2.60000  5.30000             Pliocene         Piacencian
## 31  2.60000  5.30000             Pliocene         Piacencian
## 32  2.60000  5.30000             Pliocene         Piacencian
## 33  2.60000  5.30000             Pliocene         Piacencian
## 34  3.60000  4.20000             Pliocene           Zanclean
## 35  3.60000  4.20000             Pliocene           Zanclean
## 36  3.60000  4.20000             Pliocene           Zanclean
## 37  5.00000  6.00000     Pliocene/Miocene           Zanclean
## 38  5.00000  6.00000     Pliocene/Miocene           Zanclean
## 39  5.33000  6.30000              Miocene          Messinian
## 40  5.33000  7.00000              Miocene          Messinian
## 41  0.00125  0.00229             Holocene      Late Holocene
## 42  0.00125  0.00229             Holocene      Late Holocene
## 43  0.00285  0.00075             Holocene           Holocene
## 44  0.00500  0.12700 Holocene/Pleistocene           Holocene
## 45  2.60000  5.30000             Pliocene         Piacencian
## 46  2.60000  5.30000             Pliocene         Piacencian
## 47 19.00000 20.00000              Miocene        Burdigalian
## 48 19.00000 20.00000              Miocene        Burdigalian
## 49 18.00000 18.00000              Miocene        Burdigalian
## 50 18.00000 18.00000              Miocene        Burdigalian
## 51 18.00000 18.00000              Miocene        Burdigalian
## 52 18.00000 18.00000              Miocene        Burdigalian
## 53 17.00000 17.50000              Miocene        Burdigalian
## 54 17.00000 17.50000              Miocene        Burdigalian
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## 58 17.00000 17.50000              Miocene        Burdigalian
## 59 17.00000 17.50000              Miocene        Burdigalian
## 60 17.00000 17.50000              Miocene        Burdigalian
## 61  3.60000  4.20000             Pliocene           Zanclean
## 62 13.50000 14.50000              Miocene       Serravallian
## 63  1.80000  1.90000          Pleistocene  Lower Pleistocene
```

```
## 64  9.50000 11.00000              Miocene          Tortonian
## 65  1.06000  1.38000          Pleistocene  Lower Pleistocene
## 66  1.00000  5.00000 Pleistocene/Pliocene  Lower Pleistocene
## 67  1.00000  5.00000 Pleistocene/Pliocene  Lower Pleistocene
## 68  1.00000  1.50000          Pleistocene  Lower Pleistocene
## 69  0.01200  0.12600          Pleistocene  Upper Pleistocene
## 70 10.90000 11.00000              Miocene          Tortonian
## 71 18.00000 19.00000              Miocene        Burdigalian
## 72 18.00000 19.00000              Miocene        Burdigalian
## 73  1.80000  3.60000 Pleistocene/Pliocene           Gelasian
## 74 11.20000 12.50000              Miocene          Tortonian
## 75  9.00000 11.20000              Miocene          Tortonian
## 76  9.00000 11.20000              Miocene          Tortonian
## 77  4.00000  5.00000             Pliocene           Zanclean
## 78  3.00000  3.00000             Pliocene         Piacencian
## 79  3.00000  3.00000             Pliocene         Piacencian
## 80  0.30000  0.30000          Pleistocene Middle Pleistocene
## 81  5.00000  6.00000     Pliocene/Miocene           Zanclean
## 82  5.00000  6.00000     Pliocene/Miocene           Zanclean
## 83  9.00000 10.00000              Miocene          Tortonian
## 84 15.00000 15.80000              Miocene           Langhian
## 85  1.80000  2.20000          Pleistocene           Gelasian
## 86  1.80000  2.20000          Pleistocene           Gelasian
## 87  4.80000  5.20000             Pliocene           Zanclean
## 88  3.00000  3.00000             Pliocene         Piacencian
##           lower.stage          Genus          Species
## 1           Tortonian     Geochelone         hesterna
## 2            Zanclean   Titanochelon       perpiniana
## 3            Chattian      Ergilemys          bruneti
## 4          Priabonian   Cheirogaster          maurini
## 5   Lower Pleistocene        Testudo           graeca
## 6        Serravallian        Testudo   steinheimensis
## 7        Serravallian   Paleotestudo          antiqua
## 8        Serravallian   Paleotestudo          antiqua
## 9        Serravallian   Paleotestudo          antiqua
## 10       Serravallian   Paleotestudo          antiqua
## 11       Serravallian   Paleotestudo          antiqua
## 12       Serravallian   Paleotestudo          antiqua
## 13       Serravallian   Paleotestudo          antiqua
## 14       Serravallian   Paleotestudo          antiqua
## 15       Serravallian   Paleotestudo          antiqua
## 16       Serravallian   Paleotestudo          antiqua
## 17       Serravallian   Paleotestudo          antiqua
## 18       Serravallian   Paleotestudo          antiqua
## 19       Serravallian   Paleotestudo          antiqua
## 20        Burdigalian     Geochelone              sp.
## 21        Burdigalian        Testudo     rectogularis
## 22        Burdigalian   Titanochelon   cf. perpiniana
## 23       Serravallian        Testudo   steinheimensis
## 24           Pliocene        Testudo              sp.
## 25          Messinian   Titanochelon        schafferi
## 26           Gelasian   Titanochelon   aff. schafferi
## 27         Piacencian   Titanochelon              sp.
## 28         Piacencian        Testudo       brevitesta
```

```
## 29         Piacencian        Testudo       brevitesta
## 30           Zanclean   Titanochelon      bacharidisi
## 31           Zanclean   Titanochelon      bacharidisi
## 32           Zanclean   Titanochelon      bacharidisi
## 33           Zanclean   Titanochelon      bacharidisi
## 34           Zanclean        Testudo       cf. graeca
## 35           Zanclean        Testudo              sp.
## 36           Zanclean        Testudo              sp.
## 37          Messinian        Testudo           graeca
## 38          Messinian        Testudo           graeca
## 39          Messinian        Testudo          amiatae
## 40          Messinian        Testudo              sp.
## 41      Late Holocene  Aldabrachelys      grandidieri
## 42      Late Holocene  Aldabrachelys      grandidieri
## 43           Holocene  Aldabrachelys          abrupta
## 44  Upper Pleistocene        Testudo           graeca
## 45           Zanclean      Ergilemys       oskarkuhni
## 46           Zanclean      Ergilemys       oskarkuhni
## 47        Burdigalian   Namibchersus      namaquensis
## 48        Burdigalian   Namibchersus      namaquensis
## 49        Burdigalian   Namibchersus      namaquensis
## 50        Burdigalian   Namibchersus      namaquensis
## 51        Burdigalian   Namibchersus      namaquensis
## 52        Burdigalian   Namibchersus      namaquensis
## 53        Burdigalian     Mesocherus         orangeus
## 54        Burdigalian     Mesocherus         orangeus
## 55        Burdigalian     Mesocherus         orangeus
## 56        Burdigalian     Mesocherus         orangeus
## 57        Burdigalian     Mesocherus         orangeus
## 58        Burdigalian   Namibchersus aff. namaquensis
## 59        Burdigalian   Namibchersus aff. namaquensis
## 60        Burdigalian   Namibchersus aff. namaquensis
## 61           Zanclean        Testudo              sp.
## 62           Langhian      Ergilemys              sp.
## 63  Lower Pleistocene   Titanochelon              sp.
## 64          Tortonian   Cheirogaster              sp.
## 65  Lower Pleistocene    Eurotestudo         hermanni
## 66           Zanclean  Aldabrachelys            ? sp.
## 67           Zanclean  Aldabrachelys            ? sp.
## 68  Lower Pleistocene Hesperotestudo    crassiscutata
## 69  Upper Pleistocene Hesperotestudo           incisa
## 70          Tortonian Hesperotestudo           alleni
## 71        Burdigalian     Geochelone        tedwhitei
## 72        Burdigalian     Geochelone        tedwhitei
## 73         Piacencian       Gopherus      canyonensis
## 74       Serravallian       Gopherus            ? sp.
## 75          Tortonian     Geochelone              sp.
## 76          Tortonian       Gopherus            ? sp.
## 77           Zanclean     Geochelone              sp.
## 78         Piacencian Hesperotestudo           riggsi
## 79         Piacencian Hesperotestudo           riggsi
## 80 Middle Pleistocene Hesperotestudo        equicomes
## 81          Messinian Hesperotestudo       orthopygia
## 82          Messinian Hesperotestudo       orthopygia
```

```
## 83          Tortonian Hesperotestudo              sp.
## 84           Langhian     Floridemys            hurdi
## 85           Gelasian     Geochelone              sp.
## 86           Gelasian     Geochelone              sp.
## 87           Zanclean     Geochelone              sp.
## 88         Piacencian Hesperotestudo         oelrichi
##                            Taxon                            Author
## 1            Geochelone hesterna                     Auffenberg, 1971
## 2         Titanochelon perpiniana                      (Depéret, 1885)
## 3               Ergilemys bruneti                          Broin, 1977
## 4           Cheirogaster maurini                   Bergounioux, 1935
## 5                 Testudo graeca                      Linnaeus, 1758
## 6          Testudo steinheimensis                     (Staesche, 1931)
## 7            Paleotestudo antiqua                        (Bronn, 1831)
## 8            Paleotestudo antiqua                        (Bronn, 1831)
## 9            Paleotestudo antiqua                        (Bronn, 1831)
## 10           Paleotestudo antiqua                        (Bronn, 1831)
## 11           Paleotestudo antiqua                        (Bronn, 1831)
## 12           Paleotestudo antiqua                        (Bronn, 1831)
## 13           Paleotestudo antiqua                        (Bronn, 1831)
## 14           Paleotestudo antiqua                        (Bronn, 1831)
## 15           Paleotestudo antiqua                        (Bronn, 1831)
## 16           Paleotestudo antiqua                        (Bronn, 1831)
## 17           Paleotestudo antiqua                        (Bronn, 1831)
## 18           Paleotestudo antiqua                        (Bronn, 1831)
## 19           Paleotestudo antiqua                        (Bronn, 1831)
## 20                 Geochelone sp.                     Fitzinger, 1835
## 21          Testudo rectogularis                       Schleich, 1981
## 22   Titanochelon cf. perpiniana                      (Depéret, 1885)
## 23        Testudo steinheimensis                       Staesche, 1931
## 24                   Testudo sp.                       Linnaeus, 1758
## 25        Titanochelon schafferi                       (Szalai, 1931)
## 26   Titanochelon aff. schafferi                       (Szalai, 1931)
## 27               Titanochelon sp.       Pérez-Garcia & Vlachos, 2014
## 28             Testudo brevitesta           Vlachos & Tsoukala, 2016
## 29             Testudo brevitesta           Vlachos & Tsoukala, 2016
## 30      Titanochelon bacharidisi (Vlachos, Tsoukala & Corsini, 2014)
## 31      Titanochelon bacharidisi (Vlachos, Tsoukala & Corsini, 2014)
## 32      Titanochelon bacharidisi (Vlachos, Tsoukala & Corsini, 2014)
## 33      Titanochelon bacharidisi (Vlachos, Tsoukala & Corsini, 2014)
## 34            Testudo cf. graeca                      Linnaeus, 1758
## 35                  Testudo sp.                       Linnaeus, 1758
## 36                  Testudo sp.                       Linnaeus, 1758
## 37                Testudo graeca                      Linnaeus, 1758
## 38                Testudo graeca                      Linnaeus, 1758
## 39               Testudo amiatae                      Linnaeus, 1758
## 40                  Testudo sp.                       Linnaeus, 1758
## 41     Aldabrachelys grandidieri                     (Vaillant, 1885)
## 42     Aldabrachelys grandidieri                     (Vaillant, 1885)
## 43         Aldabrachelys abrupta                   (Grandidier, 1868)
## 44                Testudo graeca                      Linnaeus, 1758
## 45          Ergilemys oskarkuhni                    M?ynarski(, 1968)
## 46          Ergilemys oskarkuhni                    M?ynarski(, 1968)
## 47      Namibchersus namaquensis                      (Stromer, 1926)
```

```
## 48      Namibchersus namaquensis                   (Stromer, 1926)
## 49      Namibchersus namaquensis                   (Stromer, 1926)
## 50      Namibchersus namaquensis                   (Stromer, 1926)
## 51      Namibchersus namaquensis                   (Stromer, 1926)
## 52      Namibchersus namaquensis                   (Stromer, 1926)
## 53           Mesocherus orangeus            Lapparent de Broin, 2003
## 54           Mesocherus orangeus            Lapparent de Broin, 2003
## 55           Mesocherus orangeus            Lapparent de Broin, 2003
## 56           Mesocherus orangeus            Lapparent de Broin, 2003
## 57           Mesocherus orangeus            Lapparent de Broin, 2003
## 58 Namibchersus aff. namaquensis                    (Stromer, 1926)
## 59 Namibchersus aff. namaquensis                    (Stromer, 1926)
## 60 Namibchersus aff. namaquensis                    (Stromer, 1926)
## 61                   Testudo sp.                    Linnaeus, 1758
## 62                 Ergilemys sp.                  Ckhikvadze, 1972
## 63              Titanochelon sp.      Pérez-García and Vlachos, 2014
## 64              Cheirogaster sp.                 Bergounioux, 1935
## 65              Testudo hermanni                    (Gmelin, 1789)
## 66           Aldabrachelys ? sp.         Loveridge & Williams, 1975
## 67           Aldabrachelys ? sp.         Loveridge & Williams, 1975
## 68  Hesperotestudo crassiscutata                      (Leidy, 1889)
## 69         Hesperotestudo incisa                       (Hay, 1916)
## 70         Hesperotestudo alleni                (Auffenbgerg, 1996)
## 71          Geochelone tedwhitei                   (Williams, 1953)
## 72          Geochelone tedwhitei                   (Williams, 1953)
## 73          Gopherus canyonensis                   (Johnston, 1937)
## 74                Gopherus ? sp.                   Rafinesque, 1832
## 75                Geochelone sp.                    Fitzinger, 1835
## 76                Gopherus ? sp.                   Rafinesque, 1832
## 77                Geochelone sp.                    Fitzinger, 1835
## 78         Hesperotestudo riggsi                    (Hibbard, 1944)
## 79         Hesperotestudo riggsi                    (Hibbard, 1944)
## 80      Hesperotestudo equicomes                        (Hay, 1917)
## 81     Hesperotestudo orthopygia                       (Cope, 1878)
## 82     Hesperotestudo orthopygia                       (Cope, 1878)
## 83            Hesperotestudo sp.                     Williams, 1950
## 84              Floridemys hurdi                 Weems & George, 2013
## 85                Geochelone sp.                    Fitzinger, 1835
## 86                Geochelone sp.                    Fitzinger, 1835
## 87                Geochelone sp.                    Fitzinger, 1835
## 88       Hesperotestudo oelrichi                       Holman, 1972
##
## 1
## 2
## 3
## 4
## 5                                                  DM-H-14 nearly complete shell, a
## 6
## 7
## 8
## 9                                                          Neotypus: MT PAL 2012.0
## 10                                                         Neotypus: MT PAL 2012.0
## 11                                                         Neotypus: MT PAL 2012.0
## 12                                                         Neotypus: MT PAL 2012.0
```

```
## 13                                                                     Neotypus: MT PAL 2012.0
## 14                                                                     Neotypus: MT PAL 2012.0
## 15                                                                     Neotypus: MT PAL 2012.0
## 16                                                                     Neotypus: MT PAL 2012.0
## 17                                                                     Neotypus: MT PAL 2012.0
## 18
## 19
## 20
## 21
## 22
## 23
## 24
## 25
## 26
## 27
## 28 Holotypus: LGPUT MIL 495 post.p.carapace, ref.mat.: 255 fr.plastron, 256a neural, 256c fr.pygal,
## 29 Holotypus: LGPUT MIL 495 post.p.carapace, ref.mat.: 255 fr.plastron, 256a neural, 256c fr.pygal,
## 30
## 31
## 32
## 33
## 34
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## 36
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## 41
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## 43
## 44
## 45                                                                                   Holotypu
## 46                                                                                   Holotypu
## 47
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## 50
## 51
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## 53
## 54
## 55
## 56
## 57
## 58                                         MSGN old collections: PQ AD 73, PQ AD 1293, PQ AD
## 59                                         MSGN old collections: PQ AD 73, PQ AD 1293, PQ AD
## 60                                         MSGN old collections: PQ AD 73, PQ AD 1293, PQ AD
## 61
## 62
## 63
## 64
## 65                               TE14: 2 pleurals, 1 suprapygal, TE14a: 1 neural, 2 pleurals, TE
## 66
```

```
## 67
## 68                                                                      UF 64395, 65005, 80593, 843
## 69
## 70
## 71
## 72
## 73
## 74
## 75
## 76
## 77
## 78                                                                         Holotypus: KUMVP 6789 nea
## 79
## 80                    Holotypus: NMNH 10944 (cast UMMP V31427) right epiplastron, left hyoplastral
## 81
## 82
## 83
## 84
## 85                                                                     UMMP V60631 distal phalange
## 86                                                                     UMMP V60631 distal phalange
## 87
## 88     Holotypus: UMMP V56298 almost complete specimen, Paratypes: UMMP V59919 one fragmentary nuchal
##                                                     CollNo   CL
## 1                                               UCMP 40200  278
## 2                                            type locality 1140
## 3                                                    MP 29  400
## 4                                                        -  400
## 5                                                  DM-H-14  195
## 6                                           BSP 1932 I 50  111
## 7                                          BSP 1954 I 539a  203
## 8                                          BSP 1954 I 539b   NA
## 9                                       MT PAL 2012.0.10   185
## 10                                              FFSM3446.1  229
## 11                                             FFSM 3446.2  220
## 12                                             FFSM 3446.3  195
## 13                                             FFSM 3446.4  206
## 14                                 SMNS 4450 (incomplete)  195
## 15                                             SMNS 51467   NA
## 16                                             SMNS 51469  180
## 17                                                 UFGC 9  145
## 18                                                      -  152
## 19                                                      -  240
## 20                                                      - 1000
## 21                            Holotypus: BSP 1959 II 1172  213
## 22                                           1959 II 2033   NA
## 23                                                 Tüb. 1   NA
## 24                                                      - 1200
## 25                                   NHMW 2009z0103/0001 1850
## 26                                                      - 1860
## 27                                               MIL 1511   NA
## 28                                         LGPUT MIL 495  300
## 29                                        LGPUT MIL 1753   NA
## 30                                     LGPUT KLK 501-528  900
## 31                                   LGPUT EPN I 100-199 1196
```

```
## 32                                                LGPUT EPN II 200-287 1164
## 33                                                   LGPUT MIC 300-303  900
## 34                                                                   -  185
## 35                                                                   - 2500
## 36                                                                   - 2500
## 37                                                        AMPG 1970/2  200
## 38                                                          IGF 11602  167
## 39                                                            MPUM 25  140
## 40                                                           MCB 1923  200
## 41                                                      MNHN-P MAD3501 1240
## 42                                                      MNHN-P MAD3502 1250
## 43                                                      MNHN-P MAD3500 1000
## 44                                                                   -  850
## 45                                                             MgCH/15   NA
## 46                                                             MgCH/17  220
## 47 Holotype (Stromer, 1926) --> was destroyed during World War II   NA
## 48                                                 ca. 30 cm (wsl CL)  300
## 49                                                             AM 1'99  254
## 50                                                             AM 9'93  470
## 51                                                              OMS x1  470
## 52                                                               Am xf  815
## 53                                                           Holotypus  180
## 54                                                           Holotypus  160
## 55                                                           Holotypus  180
## 56                                                           Holotypus  200
## 57                                                           Holotypus  180
## 58                                                                   -   NA
## 59                                                                   -   NA
## 60                                                                   - 1100
## 61                                                                 264  500
## 62                                                                   - 1000
## 63                                                                   - 1420
## 64                                                                   - 1170
## 65                                                                   -   NA
## 66                                                                   - 1500
## 67                                                                   - 1500
## 68                                                               80593   NA
## 69                      7 specimens: 192.0-264.0 mm (mean=211.6 mm)   NA
## 70                                                            UF 9370   NA
## 71                                                           MCZ 2020  370
## 72                                                           MCZ 2021   NA
## 73                                                       TPPHM 1534    NA
## 74                         several specimens, no exact number given  500
## 75                         several specimens, no exact number given  500
## 76                         several specimens, no exact number given  500
## 77                                       CL: 88 cm, PL: 70 cm  880
## 78                                                 KUMVP 6789  176
## 79                                                 KUMVP 6790  185
## 80                                                 NMNH 10944   NA
## 81                                                 UCMP 95918 1200
## 82                                                UCMP 131794   NA
## 83                                                 UCMP 36080 1200
## 84                                                 CMM-V-4666   NA
## 85                                                           -   NA
```

```
## 86                                                    -   NA
## 87                                          Santee Type B   NA
## 88                                            UMMP V56298   NA
##        PL           size
## 1      NA           <NA>
## 2      NA          giant
## 3      NA           <NA>
## 4      NA           <NA>
## 5      NA           <NA>
## 6   110.0           <NA>
## 7   178.0           <NA>
## 8   167.0           <NA>
## 9      NA           <NA>
## 10     NA           <NA>
## 11     NA           <NA>
## 12     NA           <NA>
## 13     NA           <NA>
## 14  186.0           <NA>
## 15  145.0           <NA>
## 16     NA           <NA>
## 17     NA           <NA>
## 18  134.0           <NA>
## 19     NA           <NA>
## 20     NA           <NA>
## 21  180.0           <NA>
## 22  910.0           <NA>
## 23  207.0           <NA>
## 24     NA          giant
## 25     NA          giant
## 26     NA           <NA>
## 27     NA          giant
## 28     NA          small
## 29  150.0          small
## 30     NA           <NA>
## 31 1150.0           <NA>
## 32 1120.0           <NA>
## 33     NA           <NA>
## 34     NA           <NA>
## 35     NA          giant
## 36     NA          giant
## 37     NA          small
## 38     NA          small
## 39  115.0           <NA>
## 40     NA           <NA>
## 41     NA          giant
## 42     NA          giant
## 43     NA          giant
## 44     NA          large
## 45  180.0           <NA>
## 46     NA           <NA>
## 47  240.0           <NA>
## 48  244.0           <NA>
## 49  225.0           <NA>
## 50  406.0           <NA>
```

```
## 51     NA            <NA>
## 52     NA            <NA>
## 53  155.0          medium
## 54     NA          medium
## 55     NA          medium
## 56     NA          medium
## 57     NA          medium
## 58  400.0           large
## 59  500.0           large
## 60     NA           large
## 61  450.0            <NA>
## 62     NA            <NA>
## 63     NA           giant
## 64     NA           giant
## 65  121.0            <NA>
## 66     NA            <NA>
## 67     NA            <NA>
## 68  510.0           small
## 69  211.6            <NA>
## 70  219.0            <NA>
## 71     NA            <NA>
## 72  400.0            <NA>
## 73  805.0            <NA>
## 74     NA            <NA>
## 75     NA            <NA>
## 76     NA            <NA>
## 77  700.0           large
## 78  189.0            <NA>
## 79     NA            <NA>
## 80     NA medium to large
## 81     NA            <NA>
## 82  620.0            <NA>
## 83     NA            <NA>
## 84     NA            <NA>
## 85     NA          larrge
## 86     NA           small
## 87  160.0            <NA>
## 88  258.0           large
##
## 1
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## 34
## 35 ...Reste von mindestens 2 Individuen. Die Größe der Krallenphalangen kann man die Größe der Schilo
## 36 ...Reste von mindestens 2 Individuen. Die Größe der Krallenphalangen kann man die Größe der Schilo
## 37
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## 88
##    estimated..e..ev..from.verbal.description..ep..from.plastron..or.measured..m..mf..measured.from.f
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```

```
##    Island Continent
## 1       n S-America
## 2       n    Europe
## 3       n    Europe
## 4       n    Europe
## 5       n   Eurasia
## 6       n    Europe
## 7       n    Europe
## 8       n    Europe
## 9       n    Europe
## 10      n    Europe
## 11      n    Europe
## 12      n    Europe
## 13      n    Europe
## 14      n    Europe
## 15      n    Europe
## 16      n    Europe
## 17      n    Europe
## 18      n    Europe
## 19      n    Europe
## 20      n    Europe
## 21      n    Europe
## 22      n    Europe
## 23      n    Europe
## 24      n    Europe
## 25      y    Europe
## 26      y    Europe
## 27      n    Europe
## 28      n    Europe
## 29      n    Europe
## 30      n    Europe
## 31      n    Europe
## 32      n    Europe
## 33      n    Europe
## 34      n    Europe
## 35      n    Europe
## 36      n    Europe
## 37      n    Europe
## 38      n    Europe
## 39      n    Europe
## 40      n    Europe
## 41      y    Africa
## 42      y    Africa
## 43      y    Africa
## 44      y    Europe
## 45      n      Asia
## 46      n      Asia
## 47      n    Africa
## 48      n    Africa
## 49      n    Africa
## 50      n    Africa
## 51      n    Africa
## 52      n    Africa
## 53      n    Africa
```

```
## 54      n    Africa
## 55      n    Africa
## 56      n    Africa
## 57      n    Africa
## 58      n    Africa
## 59      n    Africa
## 60      n    Africa
## 61      n    Europe
## 62      n   Eurasia
## 63      n    Europe
## 64      n    Europe
## 65      n    Europe
## 66      n      Asia
## 67      n      Asia
## 68      n N-America
## 69      n N-America
## 70      n N-America
## 71      n N-America
## 72      n N-America
## 73      n N-America
## 74      n N-America
## 75      n N-America
## 76      n N-America
## 77      n N-America
## 78      n N-America
## 79      n N-America
## 80      n N-America
## 81      n N-America
## 82      n N-America
## 83      n N-America
## 84      n N-America
## 85      n N-America
## 86      n N-America
## 87      n N-America
## 88      n N-America
##
## 1
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## 4
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## 7
## 8  Meylan P.A., 1995: Pleistocene amphibians and reptiles from the Leisey Shell Pit, Hillsborough Co
## 9
## 10
## 11
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```

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## 84
## 85
## 86
## 87
## 88
##          Age
## 1   8.50000
## 2   3.90000
## 3  23.11500
## 4  33.95000
## 5   1.77000
## 6  12.15000
## 7  12.15000
## 8  12.15000
## 9  13.00000
## 10 13.00000
## 11 13.00000
## 12 13.00000
## 13 13.00000
## 14 13.00000
## 15 13.00000
## 16 13.00000
## 17 13.00000
## 18 13.00000
## 19 13.00000
## 20 16.65000
## 21 16.37000
## 22 16.37000
## 23 13.00000
## 24  3.96000
## 25  6.25000
## 26  2.00000
## 27  2.60000
## 28  2.60000
## 29  2.60000
## 30  3.95000
## 31  3.95000
## 32  3.95000
## 33  3.95000
## 34  3.90000
## 35  3.90000
## 36  3.90000
## 37  5.50000
```

```
## 38  5.50000
## 39  5.81500
## 40  6.16500
## 41  0.00177
## 42  0.00177
## 43  0.00180
## 44  0.06600
## 45  3.95000
## 46  3.95000
## 47 19.50000
## 48 19.50000
## 49 18.00000
## 50 18.00000
## 51 18.00000
## 52 18.00000
## 53 17.25000
## 54 17.25000
## 55 17.25000
## 56 17.25000
## 57 17.25000
## 58 17.25000
## 59 17.25000
## 60 17.25000
## 61  3.90000
## 62 14.00000
## 63  1.85000
## 64 10.25000
## 65  1.22000
## 66  3.00000
## 67  3.00000
## 68  1.25000
## 69  0.06900
## 70 10.95000
## 71 18.50000
## 72 18.50000
## 73  2.70000
## 74 11.85000
## 75 10.10000
## 76 10.10000
## 77  4.50000
## 78  3.00000
## 79  3.00000
## 80  0.30000
## 81  5.50000
## 82  5.50000
## 83  9.50000
## 84 15.40000
## 85  2.00000
## 86  2.00000
## 87  5.00000
## 88  3.00000
```

Prepare data for conversion to paleoTS-object:

```
SampleSize <- tidyCL %>%
  dplyr::select(MAmin, Mamax, CL) %>%
  filter(CL != "NA")

length(SampleSize$CL)
```

```
## [1] 65
```

```
TidyCL <- tidyCL %>%
  dplyr::select(MAmin, Mamax, CL) %>%
  dplyr::filter(CL != "NA") %>%
  mutate(tt= (MAmin+Mamax)/2) %>% # create mean age
  group_by(tt) %>% #create time bins
  summarise(mm=mean(CL), vv=var(CL), nn=n()) #create means etc. for each time bin

TidyCL[is.na(TidyCL)]<-0 #subset NAs with 0 for

TidyCL
```

```
## # A tibble: 32 × 4
##         tt      mm        vv    nn
##      <dbl>   <dbl>     <dbl> <int>
## 1  0.00177 1245.00      50.0     2
## 2  0.00180 1000.00       0.0     1
## 3  0.06600  850.00       0.0     1
## 4  1.77000  195.00       0.0     1
## 5  1.85000 1420.00       0.0     1
## 6  2.00000 1860.00       0.0     1
## 7  2.60000  300.00       0.0     1
## 8  3.00000  840.25  580373.6     4
## 9  3.90000 1365.00 1191925.0     5
## 10 3.95000  876.00  154208.0     5
## # ... with 22 more rows
```

```
bins <- tidyCL %>%
#  select(MAmin, Mamax, CL) %>%
  filter(CL != "NA") %>%
  mutate(tt= (MAmin+Mamax)/2) %>% # create mean age
  group_by(tt)

bins
```

```
## Source: local data frame [65 x 26]
## Groups: tt [32]
##
##                                                    Locality  Country
##                                                       <fctr>   <fctr>
## 1                           San Nicolas, UCMP locality V4536 Colombia
## 2    Serrat-d´en-Vacquer near Perpignan, Pyrénées-Orientales   France
## 3  Toulouse Puits Borderouge niveau inférieur, Haute-Garonne   France
## 4                   Baby 2, Saint-André-et-Appelles, Gironde   France
## 5                                                  Dmanisi  Georgia
## 6                            Altenstadt, 7 km S Illertissen  Germany
## 7                                                Gammelsdorf  Germany
## 8             Hohenhöwen, Engen, Hegau, southwestern Germany  Germany
```

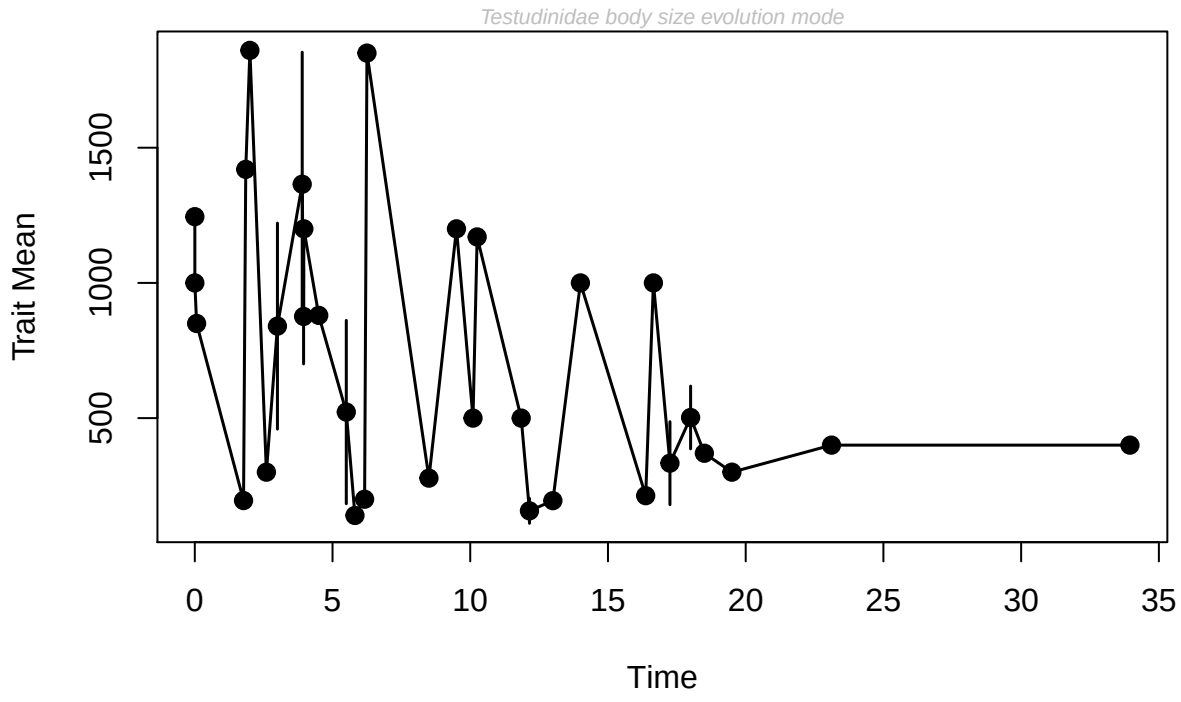
```
## 9             Hohenhöwen, Engen, Hegau, southwestern Germany  Germany
## 10            Hohenhöwen, Engen, Hegau, southwestern Germany  Germany
## # ... with 55 more rows, and 24 more variables: Latitude <dbl>,
## #   Longitude <dbl>, Formation.Location.comment <fctr>, MAmin <dbl>,
## #   Mamax <dbl>, Epoch <fctr>, upper.stage <fctr>, lower.stage <fctr>,
## #   Genus <fctr>, Species <fctr>, Taxon <fctr>, Author <fctr>,
## #   comment <fctr>, CollNo <fctr>, CL <int>, PL <dbl>, size <fctr>,
## #   verbal.description...my.comments.in.parentheses. <fctr>,
## #   estimated..e..ev..from.verbal.description..ep..from.plastron..or.measured..m..mf..measured.from.i
## #   Island <fctr>, Continent <fctr>, Reference <fctr>, Age <dbl>, tt <dbl>
```

```
library(paleoTS)
paleoTidyCL <-as.paleoTS(TidyCL$mm, TidyCL$vv, TidyCL$nn, TidyCL$tt, MM = NULL, genpars = NULL, label =
paleoTidyCL
```

```
## $mm
##  [1] 1245.0000 1000.0000  850.0000  195.0000 1420.0000 1860.0000  300.0000
##  [8]  840.2500 1365.0000  876.0000 1200.0000  880.0000  522.3333  140.0000
## [15]  200.0000 1850.0000  278.0000 1200.0000  500.0000 1170.0000  500.0000
## [22]  157.0000  194.7000 1000.0000  213.0000 1000.0000  333.3333  502.2500
## [29]  370.0000  300.0000  400.0000  400.0000
##
## $vv
##  [1]      50.0000       0.0000       0.0000       0.0000       0.0000
##  [6]       0.0000       0.0000  580373.5833 1191925.0000  154208.0000
## [11]       0.0000       0.0000  344696.3333       0.0000       0.0000
## [16]       0.0000       0.0000       0.0000       0.0000       0.0000
## [21]       0.0000    4232.0000     955.5667       0.0000       0.0000
## [26]       0.0000  141226.6667   53840.2500       0.0000       0.0000
## [31]       0.0000       0.0000
##
## $nn
##  [1]  2  1  1  1  1  1  1  4  5  5  1  1  3  1  1  1  1  1  2  1  1  2 10
## [24]  1  1  1  6  4  1  1  1  1
##
## $tt
##  [1]  0.00000  0.00003  0.06423  1.76823  1.84823  1.99823  2.59823
##  [8]  2.99823  3.89823  3.94823  3.95823  4.49823  5.49823  5.81323
## [15]  6.16323  6.24823  8.49823  9.49823 10.09823 10.24823 11.84823
## [22] 12.14823 12.99823 13.99823 16.36823 16.64823 17.24823 17.99823
## [29] 18.49823 19.49823 23.11323 33.94823
##
## $MM
## NULL
##
## $genpars
## NULL
##
## $label
## [1] "Testudinidae body size evolution mode"
##
## $start.age
## [1] 0.00177
##
## $timeDir
```

```
## [1] "increasing"
##
## attr(,"class")
## [1] "paleoTS"
```

```
plot(paleoTidyCL)
```




```
fit3models(paleoTidyCL, silent=FALSE, method="AD", pool=FALSE)   #not working with Test1, because no va
```

```
##
## Comparing 3 models [n = 31, method = AD]
##
##              logL K      AICc Akaike.wt
## GRW    -1517.3392 2 3039.1070         0
## URW    -1623.1226 1 3248.3831         0
## Stasis  -281.8636 2  568.1558         1
```

15.06.2017

Use paleoTS with data from the past 10 Mya (today - Pliocene, beginning of Miocene)

```
unique(tidyCL$Epoch)
```

```
## [1] Miocene              Pliocene             Oligocene
## [4] Eocene               Pleistocene          Pliocene/Miocene
## [7] Holocene             Holocene/Pleistocene Pleistocene/Pliocene
```

```
## 9 Levels: Eocene Holocene Holocene/Pleistocene Miocene ... Pliocene/Miocene
```

```
PleiPlioCL <- tidyCL %>%
  filter(Age < 10.000)

length(PleiPlioCL$CL)
```

```
## [1] 45
```

```
PPCL <- PleiPlioCL %>%
  select(MAmin, Mamax, CL) %>%
  filter(CL != "NA") %>%
  mutate(tt= (MAmin+Mamax)/2) %>% # create mean age
  group_by(tt) %>% #create time bins
  summarise(mm=mean(CL), vv=var(CL), nn=n()) #create means etc. for each time bin

PPCL[is.na(PPCL)]<-0 #subset NAs with 0 for

PPCL
```

```
## # A tibble: 18 × 4
##         tt        mm        vv    nn
##      <dbl>     <dbl>     <dbl> <int>
## 1  0.00177 1245.0000      50.0     2
## 2  0.00180 1000.0000       0.0     1
## 3  0.06600  850.0000       0.0     1
## 4  1.77000  195.0000       0.0     1
## 5  1.85000 1420.0000       0.0     1
## 6  2.00000 1860.0000       0.0     1
## 7  2.60000  300.0000       0.0     1
## 8  3.00000  840.2500  580373.6     4
## 9  3.90000 1365.0000 1191925.0     5
## 10 3.95000  876.0000  154208.0     5
## 11 3.96000 1200.0000       0.0     1
## 12 4.50000  880.0000       0.0     1
## 13 5.50000  522.3333  344696.3     3
## 14 5.81500  140.0000       0.0     1
## 15 6.16500  200.0000       0.0     1
## 16 6.25000 1850.0000       0.0     1
## 17 8.50000  278.0000       0.0     1
## 18 9.50000 1200.0000       0.0     1
```

```
bins <- PleiPlioCL %>%
  #  select(MAmin, Mamax, CL) %>%
  filter(CL != "NA") %>%
  mutate(tt= (MAmin+Mamax)/2) %>% # create mean age
  group_by(tt)

bins
```

```
## Source: local data frame [32 x 26]
## Groups: tt [18]
##
##                                                          Locality
##                                                            <fctr>
## 1                                  San Nicolas, UCMP locality V4536
```

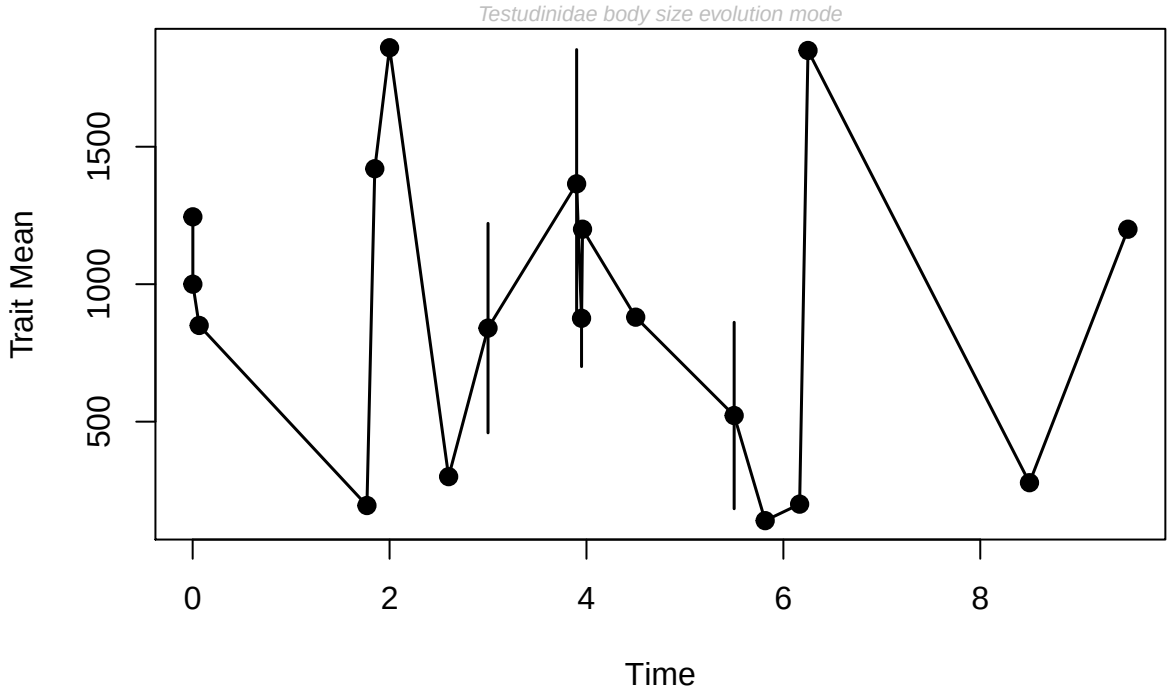
```
## 2            Serrat-d´en-Vacquer near Perpignan, Pyrénées-Orientales
## 3                                                              Dmanisi
## 4                                                 Liossati, Kiourka
## 5                                                           Samos 1
## 6                                              Lesbos Island, F-Site
## 7                                        Milia, Grevena, W Macedonia
## 8   Nea Kallikratia, western Chalkidiki Peninsula, Thessaloniki area
## 9   Epanomi (EPN I), western Chalkidiki Peninsula, Thessaloniki area
## 10 Epanomi (EPN II), western Chalkidiki Peninsula, Thessaloniki area
## # ... with 22 more rows, and 25 more variables: Country <fctr>,
## #   Latitude <dbl>, Longitude <dbl>, Formation.Location.comment <fctr>,
## #   MAmin <dbl>, Mamax <dbl>, Epoch <fctr>, upper.stage <fctr>,
## #   lower.stage <fctr>, Genus <fctr>, Species <fctr>, Taxon <fctr>,
## #   Author <fctr>, comment <fctr>, CollNo <fctr>, CL <int>, PL <dbl>,
## #   size <fctr>, verbal.description...my.comments.in.parentheses. <fctr>,
## #   estimated..e..ev..from.verbal.description..ep..from.plastron..or.measured..m..mf..measured.from.i
## #   Island <fctr>, Continent <fctr>, Reference <fctr>, Age <dbl>, tt <dbl>
```

```
paleoPPCL <-as.paleoTS(PPCL$mm, PPCL$vv, PPCL$nn, PPCL$tt, MM = NULL, genpars = NULL, label = "Testudini
paleoPPCL
```

```
## $mm
##  [1] 1245.0000 1000.0000  850.0000  195.0000 1420.0000 1860.0000  300.0000
##  [8]  840.2500 1365.0000  876.0000 1200.0000  880.0000  522.3333  140.0000
## [15]  200.0000 1850.0000  278.0000 1200.0000
##
## $vv
##  [1]      50.0       0.0       0.0       0.0       0.0       0.0       0.0
##  [8]  580373.6 1191925.0  154208.0       0.0       0.0  344696.3       0.0
## [15]       0.0       0.0       0.0       0.0
##
## $nn
##  [1] 2 1 1 1 1 1 1 4 5 5 1 1 3 1 1 1 1 1
##
## $tt
##  [1] 0.00000 0.00003 0.06423 1.76823 1.84823 1.99823 2.59823 2.99823
##  [9] 3.89823 3.94823 3.95823 4.49823 5.49823 5.81323 6.16323 6.24823
## [17] 8.49823 9.49823
##
## $MM
## NULL
##
## $genpars
## NULL
##
## $label
## [1] "Testudinidae body size evolution mode"
##
## $start.age
## [1] 0.00177
##
## $timeDir
## [1] "increasing"
##
## attr(,"class")
```

```
## [1] "paleoTS"
```

```
plot(paleoPPCL)
```

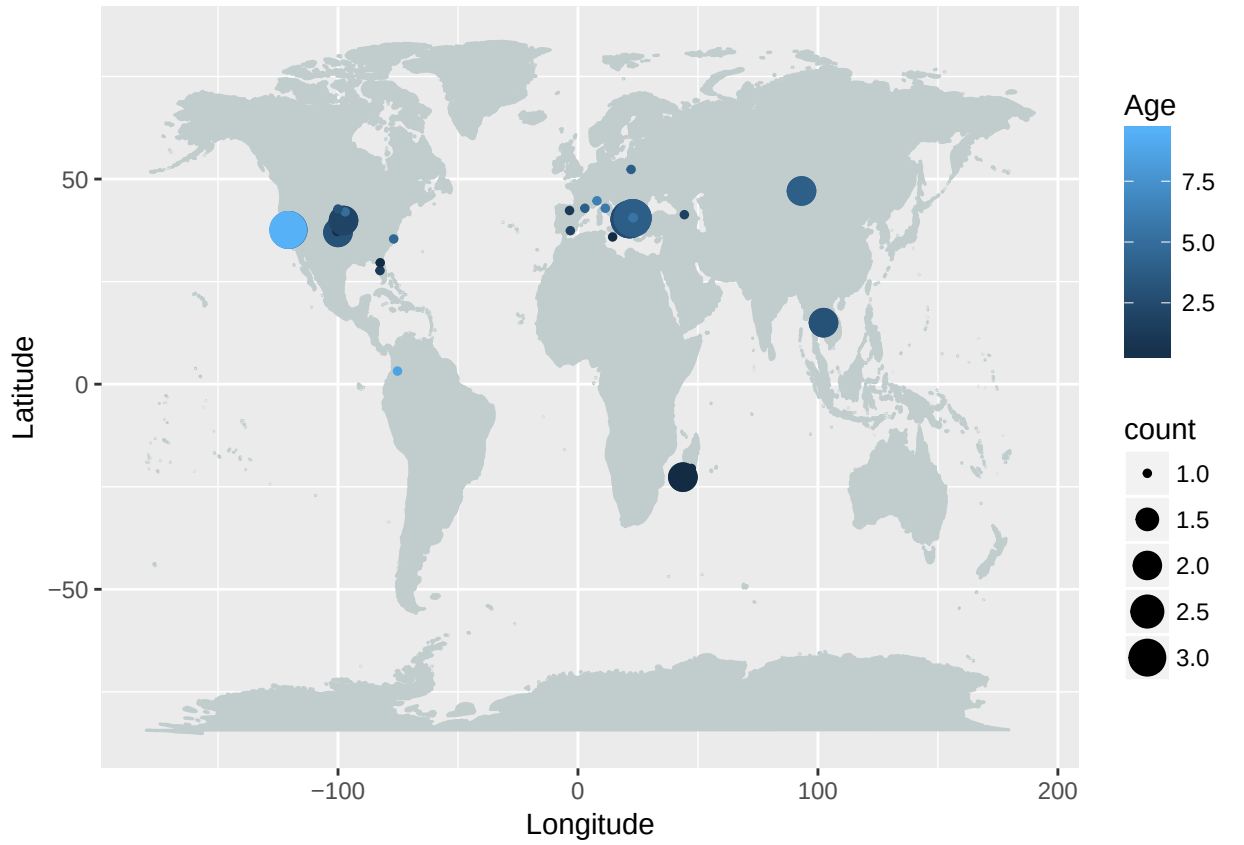



```
fit3models(paleoPPCL, silent=FALSE, method="AD", pool=FALSE)   #not working with Test1, because no vari
```

```
##
## Comparing 3 models [n = 17, method = AD]
##
##              logL K      AICc Akaike.wt
## GRW    -1307.1676 2 2619.1924         0
## URW    -1243.6540 1 2489.5747         0
## Stasis  -173.7119 2  352.2809         1
```

```
PPmap <- PleiPlioCL %>%
  select(Genus, Taxon, Latitude, Longitude, Country, CL, PL, Age) %>%
  group_by(Latitude) %>%
  mutate(count= n()) %>%
  ggplot(aes(Longitude, Latitude)) + mapWorld +
  geom_point(aes(Longitude, Latitude,colour=Age, size=count))

PPmap
```




```
ggplotly(PPmap)
```

```
## We recommend that you use the dev version of ggplot2 with `ggplotly()`
## Install it with: `devtools::install_github('hadley/ggplot2')`
```

TO DO:

- finish data set
-

This is an R Markdown Notebook. When you execute code within the notebook, the results appear beneath the code.

Try executing this chunk by clicking the *Run* button within the chunk or by placing your cursor inside it and pressing *Ctrl+Shift+Enter*.

Add a new chunk by clicking the *Insert Chunk* button on the toolbar or by pressing *Ctrl+Alt+I*.

When you save the notebook, an HTML file containing the code and output will be saved alongside it (click the *Preview* button or press *Ctrl+Shift+K* to preview the HTML file).