

diversity-through-time

Today we will use paleotree to plot diversity through time for stratigraphic range data from paelodb. First lets get some occurrence data. Paleotree can work with all of the occurrences.

```
## Loading required package: raster

## Loading required package: sp

## Loading required package: maps

## Loading required package: ape

## Warning: package 'ape' was built under R version 3.3.2

##
## Attaching package: 'ape'

## The following objects are masked from 'package:raster':
##
##      rotate, zoom
```

```
data(graptPBDB)
head(graptOccPBDB)
```

```
##      occurrence_no record_type reid_no obsolete collection_no
## 1             1669  occurrence      NA      NA           215
## 2             2186  occurrence      NA      NA           256
## 3             2216  occurrence      NA      NA           258
## 4             2217  occurrence      NA      NA           258
## 5             2318  occurrence      NA      NA           270
## 6             2319  occurrence      NA      NA           270
##      identified_name identified_rank identified_no taxonomic_reason
## 1 Chaunograptus sp.          genus          33800
## 2 Dendrograptus sp.          genus          33551
## 3 Acanthograptus sp.          genus          33536
## 4 Dendrograptus sp.          genus          33551
## 5 Dendrograptus sp.          genus          33551
## 6 Hallograptus sp.           genus          33673
##      accepted_name accepted_rank accepted_no early_interval late_interval
## 1 Chaunograptus          genus          33800      St Davids      St Davids
## 2 Dendrograptus          genus          33551 Trempealeauan Trempealeauan
## 3 Acanthograptus          genus          33536      Cambrian      Cambrian
## 4 Dendrograptus          genus          33551      Cambrian      Cambrian
## 5 Dendrograptus          genus          33551      Tremadoc      Tremadoc
## 6 Hallograptus           genus          33673      Tremadoc      Tremadoc
##      early_age late_age reference_no  primary_name primary_reso
## 1         513.0   501.0           13 Chaunograptus
## 2         501.0   485.4           13 Dendrograptus
## 3         541.0   485.4           13 Acanthograptus
```

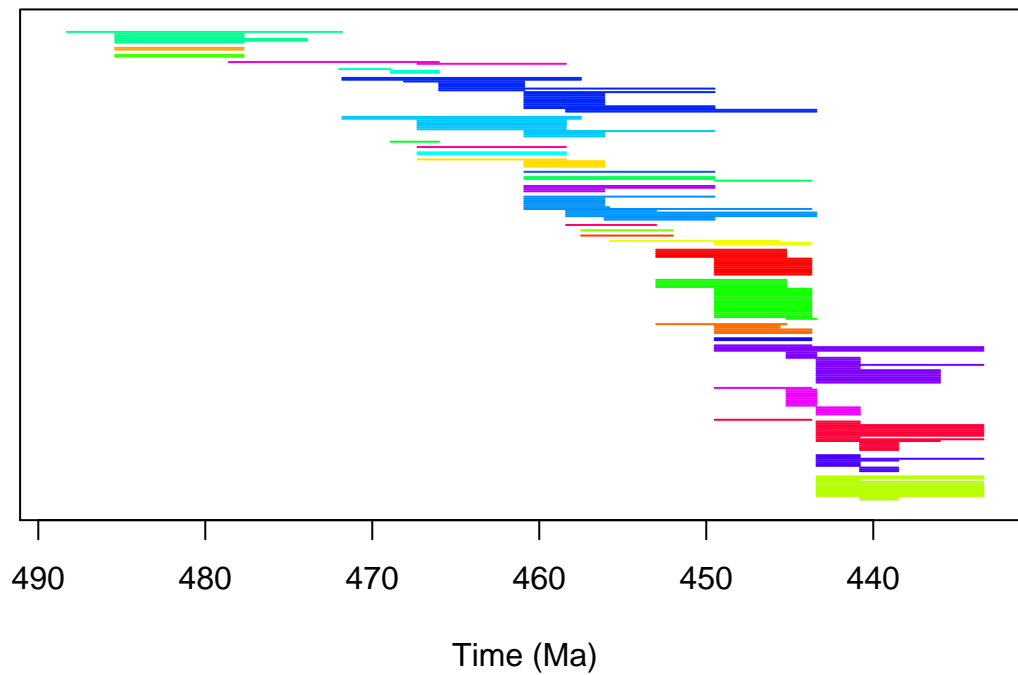
```
## 4      541.0      485.4          13 Dendrograptus
## 5      485.4      477.7          13 Dendrograptus
## 6      485.4      477.7          13 Hallograptus
##      subgenus_name subgenus_reso species_name species_reso subgenus
## 1
## 2
## 3
## 4
## 5
## 6
##      subgenus_no      genus genus_no family family_no      order
## 1      NA Chaunograptus    33800      NA
## 2      NA Dendrograptus    33551      NA Dendroidea
## 3      NA Acanthograptus    33536      NA Dendroidea
## 4      NA Dendrograptus    33551      NA Dendroidea
## 5      NA Dendrograptus    33551      NA Dendroidea
## 6      NA Hallograptus     33673      NA Graptoloidea
##      order_no      class class_no      phylum phylum_no authorizer
## 1      NA Graptolithina    33534 Hemichordata    33518 Sepkoski, J.
## 2    33535 Graptolithina    33534 Hemichordata    33518 Sepkoski, J.
## 3    33535 Graptolithina    33534 Hemichordata    33518 Sepkoski, J.
## 4    33535 Graptolithina    33534 Hemichordata    33518 Sepkoski, J.
## 5    33535 Graptolithina    33534 Hemichordata    33518 Sepkoski, J.
## 6    33606 Graptolithina    33534 Hemichordata    33518 Sepkoski, J.
##      enterer modifier
## 1 Sommers, M. unknown
## 2 Sommers, M. unknown
## 3 Sommers, M. unknown
## 4 Sommers, M. unknown
## 5 Sommers, M. unknown
## 6 Sommers, M. unknown
```

```
# lets look at uncertainty for species and genera
```

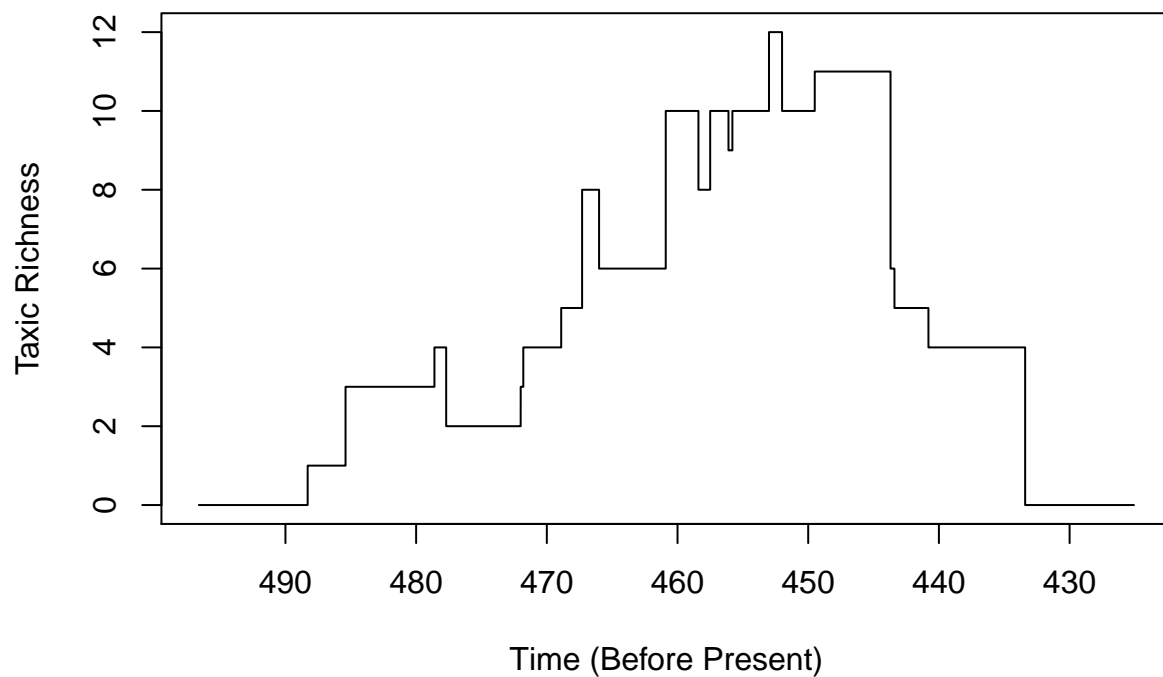
```
# graptOccPBDB <- canids ### does not work, canid data set is formatted differently but not sure why.
```

```
#graptOccPBDB <- canids
#dev.new()
#get data
data(graptPBDB)
#get species sorted occurrences
occSpecies<-taxonSortPBDBocc(graptOccPBDB, rank="species")
#plot species occurrences
plotOccData(occSpecies,groupLabel = "Species")
```

Age Uncertainty of Occurrence Data for Species



```
# convert occurrence data to "timelist" format  
graptTimeSpecies<-occData2timeList(occList=occSpecies)  
#plot diversity trthrough time  
taxicDivDisc(graptTimeSpecies)
```



```
head(graptTimeSpecies)
```

```
## $intTimes
##      startTime endTime
## [1,]      488.3    477.7
## [2,]      485.4    477.7
## [3,]      485.4    471.8
## [4,]      478.6    466.0
## [5,]      472.0    468.9
## [6,]      471.8    460.9
## [7,]      471.8    458.4
## [8,]      468.9    466.0
## [9,]      467.3    458.4
## [10,]     460.9    456.1
## [11,]     460.9    449.5
## [12,]     458.4    453.0
## [13,]     458.4    443.4
## [14,]     457.5    452.0
## [15,]     456.1    443.4
## [16,]     455.8    445.6
## [17,]     453.0    445.6
## [18,]     453.0    445.2
## [19,]     449.5    443.7
## [20,]     445.2    443.4
## [21,]     443.4    440.8
## [22,]     443.4    433.4
## [23,]     440.8    433.4
##
## $taxonTimes
##                               firstInt lastInt
## Adelograptus antiquus           1         3
## Adelograptus clarki             2         2
## Amplexograptus rugosus          14        14
## Azygograptus novozealandicus     9        10
## Climacograptus bicornis          10        15
## Climacograptus scalaris          19        23
## Corynoides incurvus              14        14
## Corynoides tricornis             10        11
## Cryptograptus schaferi            7        11
## Cryptograptus tricornis           6        13
## Dicellograptus anceps            16        19
## Dicellograptus complanatus        17        19
## Dicellograptus ornatus            18        20
## Dicranograptus ramosus           12        12
## Dictyonema pulchellum             2         2
## Didymograptus nicholsoni          4         9
## Diplograptus hughesi             21        23
## Geniculograptus pygmaeus          11        19
## Goniograptus macer                5         8
## Goniograptus speciosus            8         8
## Metabolograptus persculptus       19        21
## Normalograptus normalis           19        22
## Parabrograptus tribrachiatus      11        11
```

## Pleurograptus linearis	19	19
## Pleurograptus lui	18	19
## Pterograptus elegans	9	9
## Rhaphidograptus toernquisti	21	23
## Tetragraptus insuetus	9	9

```
head(occSpecies)
```

```
## $`Adelograptus antiquus`
##      occurrence_no record_type reid_no obsolete collection_no
## 3609      596430  occurrence      NA      NA      63189
## 3612      596434  occurrence      NA      NA      63190
## 3627      596451  occurrence      NA      NA      63192
## 3630      596454  occurrence      NA      NA      63194
## 3632      596458  occurrence      NA      NA      63195
## 3667      596498  occurrence      NA      NA      63204
## 4223      826761  occurrence      NA      NA      91172
##      identified_name identified_rank identified_no
## 3609 Adelograptus ? antiquus      species      84007
## 3612 Adelograptus ? antiquus      species      84007
## 3627 Adelograptus ? antiquus      species      84007
## 3630 Adelograptus ? antiquus      species      84007
## 3632 Adelograptus ? antiquus      species      84007
## 3667 Adelograptus ? antiquus      species      84007
## 4223 Adelograptus antiquus      species      84007
##      taxonomic_reason      accepted_name accepted_rank accepted_no
## 3609      <NA> Adelograptus antiquus      species      84007
## 3612      <NA> Adelograptus antiquus      species      84007
## 3627      <NA> Adelograptus antiquus      species      84007
## 3630      <NA> Adelograptus antiquus      species      84007
## 3632      <NA> Adelograptus antiquus      species      84007
## 3667      <NA> Adelograptus antiquus      species      84007
## 4223      <NA> Adelograptus antiquus      species      84007
##      early_interval late_interval early_age late_age reference_no
## 3609 Tremadocian Tremadocian 485.4 477.7 18179
## 3612 Lancefieldian Bendigonian 485.4 473.9 18179
## 3627 Lancefieldian Bendigonian 485.4 473.9 18179
## 3630 Tremadocian Tremadocian 485.4 477.7 18179
## 3632 Tremadocian Tremadocian 485.4 477.7 18179
## 3667 Tremadocian Tremadocian 485.4 477.7 18179
## 4223 Ibexian Ibexian 488.3 471.8 24434
##      primary_name primary_reso subgenus_name subgenus_reso species_name
## 3609 Adelograptus      ?      <NA>      <NA>      antiquus
## 3612 Adelograptus      ?      <NA>      <NA>      antiquus
## 3627 Adelograptus      ?      <NA>      <NA>      antiquus
## 3630 Adelograptus      ?      <NA>      <NA>      antiquus
## 3632 Adelograptus      ?      <NA>      <NA>      antiquus
## 3667 Adelograptus      ?      <NA>      <NA>      antiquus
## 4223 Adelograptus      <NA>      <NA>      <NA>      antiquus
##      species_reso subgenus subgenus_no      genus genus_no family
## 3609      <NA>      NA      NA Adelograptus 33537 <NA>
## 3612      <NA>      NA      NA Adelograptus 33537 <NA>
## 3627      <NA>      NA      NA Adelograptus 33537 <NA>
## 3630      <NA>      NA      NA Adelograptus 33537 <NA>
```

```

## 3632      <NA>      NA      NA Adelograptus      33537 <NA>
## 3667      <NA>      NA      NA Adelograptus      33537 <NA>
## 4223      <NA>      NA      NA Adelograptus      33537 <NA>
##      family_no      order order_no      class class_no      phylum
## 3609      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3612      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3627      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3630      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3632      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3667      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 4223      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
##      phylum_no      authorizer      enterer      modifier
## 3609      33518      Hendy, A.      Hendy, A.      Hendy, A.
## 3612      33518      Hendy, A.      Hendy, A.      unknown
## 3627      33518      Hendy, A.      Hendy, A.      unknown
## 3630      33518      Hendy, A.      Hendy, A.      Hendy, A.
## 3632      33518      Hendy, A.      Hendy, A.      unknown
## 3667      33518      Hendy, A.      Hendy, A.      unknown
## 4223      33518      Villier, L.      Villier, L.      unknown
##
## $`Adelograptus clarki`
##      occurrence_no record_type reid_no obsolete collection_no
## 3610      596431 occurrence      NA      NA      63189
## 3633      596459 occurrence      NA      NA      63195
##      identified_name identified_rank identified_no taxonomic_reason
## 3610 Adelograptus clarki      species      84009      <NA>
## 3633 Adelograptus clarki      species      84009      <NA>
##      accepted_name accepted_rank accepted_no early_interval
## 3610 Adelograptus clarki      species      84009      Tremadocian
## 3633 Adelograptus clarki      species      84009      Tremadocian
##      late_interval early_age late_age reference_no primary_name
## 3610      Tremadocian      485.4      477.7      18179 Adelograptus
## 3633      Tremadocian      485.4      477.7      18179 Adelograptus
##      primary_reso subgenus_name subgenus_reso species_name species_reso
## 3610      <NA>      <NA>      <NA>      clarki      <NA>
## 3633      <NA>      <NA>      <NA>      clarki      <NA>
##      subgenus subgenus_no      genus genus_no family family_no
## 3610      NA      NA      Adelograptus      33537 <NA>      NA
## 3633      NA      NA      Adelograptus      33537 <NA>      NA
##      order order_no      class class_no      phylum phylum_no
## 3610 Dendroidea      33535 Graptolithina      33534 Hemichordata      33518
## 3633 Dendroidea      33535 Graptolithina      33534 Hemichordata      33518
##      authorizer      enterer      modifier
## 3610      Hendy, A.      Hendy, A.      Hendy, A.
## 3633      Hendy, A.      Hendy, A.      unknown
##
## $`Amplexograptus rugosus`
##      occurrence_no record_type reid_no obsolete collection_no
## 5893      1256955 occurrence      NA      NA      166800
##      identified_name identified_rank identified_no taxonomic_reason
## 5893 Amplexograptus rugosus      species      315895      <NA>
##      accepted_name accepted_rank accepted_no early_interval
## 5893 Amplexograptus rugosus      species      315895      Longvillian
##      late_interval early_age late_age reference_no primary_name

```

```

## 5893 Marshbrookian      457.5      452      102 Amplexograptus
##      primary_reso subgenus_name subgenus_reso species_name species_reso
## 5893      <NA>      <NA>      <NA>      rugosus      <NA>
##      subgenus subgenus_no      genus genus_no family family_no
## 5893      NA      NA Amplexograptus      33615      <NA>      NA
##      order order_no      class class_no      phylum phylum_no
## 5893 Graptoloidea      33606 Graptolithina      33534 Hemichordata      33518
##      authorizer      enterer modifier
## 5893 Wagner, P. Wagner, P.      unknown
##
## $`Azygograptus novozealandicus`
##      occurrence_no record_type reid_no obsolete collection_no
## 3898      601800 occurrence      NA      NA      63967
## 3960      601885 occurrence      NA      NA      63960
## 3964      601889 occurrence      NA      NA      63961
## 3993      601921 occurrence      NA      NA      63963
## 4014      601945 occurrence      NA      NA      63965
##
##      identified_name identified_rank identified_no
## 3898      Azygograptus novozealandicus      species      84630
## 3960      Azygograptus novozealandicus      species      84630
## 3964      Azygograptus novozealandicus      species      84630
## 3993 Azygograptus novozealandicus n. sp.      species      84630
## 4014      Azygograptus novozealandicus      species      84630
##
##      taxonomic_reason      accepted_name accepted_rank
## 3898      <NA> Azygograptus novozealandicus      species
## 3960      <NA> Azygograptus novozealandicus      species
## 3964      <NA> Azygograptus novozealandicus      species
## 3993      <NA> Azygograptus novozealandicus      species
## 4014      <NA> Azygograptus novozealandicus      species
##
##      accepted_no early_interval late_interval early_age late_age
## 3898      84630      Gisbornian      Gisbornian      460.9      456.1
## 3960      84630      Gisbornian      Gisbornian      460.9      456.1
## 3964      84630      Gisbornian      Gisbornian      460.9      456.1
## 3993      84630      Darriwilian      Darriwilian      467.3      458.4
## 4014      84630      Gisbornian      Gisbornian      460.9      456.1
##
##      reference_no primary_name primary_reso subgenus_name subgenus_reso
## 3898      18428 Azygograptus      <NA>      <NA>      <NA>
## 3960      18428 Azygograptus      <NA>      <NA>      <NA>
## 3964      18428 Azygograptus      <NA>      <NA>      <NA>
## 3993      18428 Azygograptus      <NA>      <NA>      <NA>
## 4014      18428 Azygograptus      <NA>      <NA>      <NA>
##
##      species_name species_reso subgenus subgenus_no      genus
## 3898 novozealandicus      <NA>      NA      NA Azygograptus
## 3960 novozealandicus      <NA>      NA      NA Azygograptus
## 3964 novozealandicus      <NA>      NA      NA Azygograptus
## 3993 novozealandicus      n. sp.      NA      NA Azygograptus
## 4014 novozealandicus      <NA>      NA      NA Azygograptus
##
##      genus_no family family_no      order order_no      class
## 3898      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 3960      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 3964      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 3993      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 4014      33628      <NA>      NA Graptoloidea      33606 Graptolithina
##
##      class_no      phylum phylum_no authorizer      enterer modifier

```

##	3898	33534 Hemichordata	33518	Hendy, A.	Hendy, A.	unknown
##	3960	33534 Hemichordata	33518	Hendy, A.	Hendy, A.	unknown
##	3964	33534 Hemichordata	33518	Hendy, A.	Hendy, A.	unknown
##	3993	33534 Hemichordata	33518	Hendy, A.	Hendy, A.	unknown
##	4014	33534 Hemichordata	33518	Hendy, A.	Hendy, A.	unknown
##						
##		\$`Climacograptus bicornis`				
##		occurrence_no	record_type	reid_no	obsolete	collection_no
##	2399	246238	occurrence	NA	NA	24117
##	4166	748935	occurrence	NA	NA	80104
##	4320	955088	occurrence	NA	NA	111711
##	4325	955095	occurrence	NA	NA	111713
##	4332	955103	occurrence	NA	NA	111718
##	4516	996584	occurrence	NA	NA	120528
##	4685	1139721	occurrence	NA	NA	145233
##	4695	1139731	occurrence	NA	NA	145236
##	4703	1139741	occurrence	NA	NA	145237
##	4713	1139751	occurrence	NA	NA	145238
##	4725	1139763	occurrence	NA	NA	145240
##	4773	1141828	occurrence	NA	NA	145463
##	4774	1141829	occurrence	NA	NA	145464
##	5330	1144012	occurrence	NA	NA	145615
##		identified_name	identified_rank	identified_no		
##	2399	Climacograptus bicornis	species	306375		
##	4166	Climacograptus bicornis	species	306375		
##	4320	Climacograptus bicornis	species	306375		
##	4325	Climacograptus bicornis	species	306375		
##	4332	Climacograptus bicornis	species	306375		
##	4516	Climacograptus bicornis	species	306375		
##	4685	Climacograptus bicornis	species	306375		
##	4695	Climacograptus bicornis	species	306375		
##	4703	Climacograptus bicornis	species	306375		
##	4713	Climacograptus bicornis	species	306375		
##	4725	Climacograptus bicornis	species	306375		
##	4773	Climacograptus bicornis	species	306375		
##	4774	Climacograptus bicornis	species	306375		
##	5330	Climacograptus bicornis	species	306375		
##		taxonomic_reason	accepted_name	accepted_rank	accepted_no	
##	2399	<NA>	Climacograptus bicornis	species	306375	
##	4166	<NA>	Climacograptus bicornis	species	306375	
##	4320	<NA>	Climacograptus bicornis	species	306375	
##	4325	<NA>	Climacograptus bicornis	species	306375	
##	4332	<NA>	Climacograptus bicornis	species	306375	
##	4516	<NA>	Climacograptus bicornis	species	306375	
##	4685	<NA>	Climacograptus bicornis	species	306375	
##	4695	<NA>	Climacograptus bicornis	species	306375	
##	4703	<NA>	Climacograptus bicornis	species	306375	
##	4713	<NA>	Climacograptus bicornis	species	306375	
##	4725	<NA>	Climacograptus bicornis	species	306375	
##	4773	<NA>	Climacograptus bicornis	species	306375	
##	4774	<NA>	Climacograptus bicornis	species	306375	
##	5330	<NA>	Climacograptus bicornis	species	306375	
##		early_interval	late_interval	early_age	late_age	reference_no
##	2399	Trentonian	Richmondian	460.9	443.7	6817

##	4166	Idavere	Idavere	460.9	455.8	26936	
##	4320	Late Ordovician	Late Ordovician	458.4	443.4	36540	
##	4325	Late Ordovician	Late Ordovician	458.4	443.4	36540	
##	4332	Late Ordovician	Late Ordovician	458.4	443.4	36540	
##	4516	Sandbian	Sandbian	458.4	453.0	38521	
##	4685	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4695	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4703	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4713	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4725	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4773	Eastonian	Eastonian	456.1	449.5	46966	
##	4774	Eastonian	Eastonian	456.1	449.5	46966	
##	5330	Caradocian	Caradocian	460.9	449.5	47089	
##		primary_name	primary_reso	subgenus_name	subgenus_reso	species_name	
##	2399	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4166	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4320	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4325	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4332	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4516	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4685	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4695	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4703	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4713	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4725	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4773	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4774	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	5330	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##		species_reso	subgenus	subgenus_no	genus	genus_no	
##	2399	<NA>	NA	NA	Climacograptus	33636	
##	4166	<NA>	NA	NA	Climacograptus	33636	
##	4320	<NA>	NA	NA	Climacograptus	33636	
##	4325	<NA>	NA	NA	Climacograptus	33636	
##	4332	<NA>	NA	NA	Climacograptus	33636	
##	4516	<NA>	NA	NA	Climacograptus	33636	
##	4685	<NA>	NA	NA	Climacograptus	33636	
##	4695	<NA>	NA	NA	Climacograptus	33636	
##	4703	<NA>	NA	NA	Climacograptus	33636	
##	4713	<NA>	NA	NA	Climacograptus	33636	
##	4725	<NA>	NA	NA	Climacograptus	33636	
##	4773	<NA>	NA	NA	Climacograptus	33636	
##	4774	<NA>	NA	NA	Climacograptus	33636	
##	5330	<NA>	NA	NA	Climacograptus	33636	
##		family	family_no	order	order_no	class	class_no
##	2399	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4166	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4320	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4325	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4332	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4516	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4685	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4695	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4703	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4713	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534

##	4725	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4773	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4774	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5330	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##		phylum	phylum_no	authorizer	enterer	modifier	
##	2399	Hemichordata	33518	Holland, S.	Hanson, T.	unknown	
##	4166	Hemichordata	33518	Novack-Gottshall, P.	Hearn, P.	Wagner, P.	
##	4320	Hemichordata	33518	Miller, A.	Kolbe, S.	Kolbe, S.	
##	4325	Hemichordata	33518	Miller, A.	Kolbe, S.	unknown	
##	4332	Hemichordata	33518	Miller, A.	Kolbe, S.	unknown	
##	4516	Hemichordata	33518	Kiessling, W.	Merkel, U.	unknown	
##	4685	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4695	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
##	4703	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4713	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4725	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4773	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
##	4774	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
##	5330	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##							
##		\$`Climacograptus scalaris`					
##		occurrence_no	record_type	reid_no	obsolete	collection_no	
##	233	41894	occurrence	NA	NA	3281	
##	236	41899	occurrence	NA	NA	3282	
##	2530	260374	occurrence	NA	NA	25168	
##	2884	285928	occurrence	NA	NA	27197	
##	2948	287240	occurrence	NA	NA	27388	
##	3173	291182	occurrence	NA	NA	27782	
##	3246	292390	occurrence	NA	NA	27838	
##	5115	1143763	occurrence	NA	NA	145587	
##	5122	1143780	occurrence	NA	NA	145589	
##	5132	1143790	occurrence	NA	NA	145590	
##	5154	1143812	occurrence	NA	NA	145591	
##	5204	1143865	occurrence	NA	NA	145598	
##	5344	1144116	occurrence	NA	NA	145653	
##	5355	1144128	occurrence	NA	NA	145654	
##	5365	1144142	occurrence	NA	NA	145655	
##	5385	1144162	occurrence	NA	NA	145656	
##	5871	1218886	occurrence	NA	NA	159343	
##	5896	1257991	occurrence	NA	NA	166909	
##		identified_name	identified_rank	identified_no			
##	233	Climacograptus scalaris	species	316364			
##	236	Climacograptus scalaris	species	316364			
##	2530	Climacograptus scalaris	species	316364			
##	2884	Climacograptus scalaris	species	316364			
##	2948	Climacograptus scalaris	species	316364			
##	3173	Climacograptus scalaris	species	316364			
##	3246	Climacograptus scalaris	species	316364			
##	5115	Climacograptus scalaris	species	316364			
##	5122	Climacograptus ? scalaris	species	316364			
##	5132	Climacograptus scalaris	species	316364			
##	5154	Climacograptus scalaris	species	316364			
##	5204	Climacograptus scalaris	species	316364			
##	5344	Climacograptus scalaris	species	316364			

##	5355	Climacograptus	scalaris	species	316364	
##	5365	Climacograptus	scalaris	species	316364	
##	5385	Climacograptus	scalaris	species	316364	
##	5871	Climacograptus	scalaris	species	316364	
##	5896	Climacograptus	scalaris	species	316364	
##		taxonomic_reason	accepted_name	accepted_rank	accepted_no	
##	233	<NA>	Climacograptus scalaris	species	316364	
##	236	<NA>	Climacograptus scalaris	species	316364	
##	2530	<NA>	Climacograptus scalaris	species	316364	
##	2884	<NA>	Climacograptus scalaris	species	316364	
##	2948	<NA>	Climacograptus scalaris	species	316364	
##	3173	<NA>	Climacograptus scalaris	species	316364	
##	3246	<NA>	Climacograptus scalaris	species	316364	
##	5115	<NA>	Climacograptus scalaris	species	316364	
##	5122	<NA>	Climacograptus scalaris	species	316364	
##	5132	<NA>	Climacograptus scalaris	species	316364	
##	5154	<NA>	Climacograptus scalaris	species	316364	
##	5204	<NA>	Climacograptus scalaris	species	316364	
##	5344	<NA>	Climacograptus scalaris	species	316364	
##	5355	<NA>	Climacograptus scalaris	species	316364	
##	5365	<NA>	Climacograptus scalaris	species	316364	
##	5385	<NA>	Climacograptus scalaris	species	316364	
##	5871	<NA>	Climacograptus scalaris	species	316364	
##	5896	<NA>	Climacograptus scalaris	species	316364	
##		early_interval	late_interval	early_age	late_age	reference_no
##	233	Aeronian	Aeronian	440.8	438.5	155
##	236	Aeronian	Aeronian	440.8	438.5	155
##	2530	Alexandrian	Alexandrian	443.4	436.0	7063
##	2884	Llandovery	Llandovery	443.4	433.4	7455
##	2948	Rhuddanian	Rhuddanian	443.4	440.8	7455
##	3173	Llandovery	Llandovery	443.4	433.4	7624
##	3246	Llandovery	Llandovery	443.4	433.4	7624
##	5115	Llandovery	Llandovery	443.4	433.4	47076
##	5122	Llandovery	Llandovery	443.4	433.4	47076
##	5132	Llandovery	Llandovery	443.4	433.4	47076
##	5154	Llandovery	Llandovery	443.4	433.4	47076
##	5204	Llandovery	Llandovery	443.4	433.4	47083
##	5344	Rhuddanian	Rhuddanian	443.4	440.8	47103
##	5355	Rhuddanian	Rhuddanian	443.4	440.8	47103
##	5365	Aeronian	Aeronian	440.8	438.5	47103
##	5385	Aeronian	Aeronian	440.8	438.5	47103
##	5871	Aeronian	Aeronian	440.8	438.5	52096
##	5896	Bolindian	Bolindian	449.5	443.7	78
##		primary_name	primary_reso	subgenus_name	subgenus_reso	species_name
##	233	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	236	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	2530	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	2884	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	2948	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	3173	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	3246	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	5115	Climacograptus	<NA>	<NA>	<NA>	scalaris
##	5122	Climacograptus	?	<NA>	<NA>	scalaris
##	5132	Climacograptus	<NA>	<NA>	<NA>	scalaris

##	5154	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5204	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5344	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5355	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5365	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5385	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5871	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5896	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##		species_reso	subgenus	subgenus_no	genus	genus_no	
##	233	<NA>	NA	NA	Climacograptus	33636	
##	236	<NA>	NA	NA	Climacograptus	33636	
##	2530	<NA>	NA	NA	Climacograptus	33636	
##	2884	<NA>	NA	NA	Climacograptus	33636	
##	2948	<NA>	NA	NA	Climacograptus	33636	
##	3173	<NA>	NA	NA	Climacograptus	33636	
##	3246	<NA>	NA	NA	Climacograptus	33636	
##	5115	<NA>	NA	NA	Climacograptus	33636	
##	5122	<NA>	NA	NA	Climacograptus	33636	
##	5132	<NA>	NA	NA	Climacograptus	33636	
##	5154	<NA>	NA	NA	Climacograptus	33636	
##	5204	<NA>	NA	NA	Climacograptus	33636	
##	5344	<NA>	NA	NA	Climacograptus	33636	
##	5355	<NA>	NA	NA	Climacograptus	33636	
##	5365	<NA>	NA	NA	Climacograptus	33636	
##	5385	<NA>	NA	NA	Climacograptus	33636	
##	5871	<NA>	NA	NA	Climacograptus	33636	
##	5896	<NA>	NA	NA	Climacograptus	33636	
##		family	family_no	order	order_no	class	class_no
##	233	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	236	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	2530	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	2884	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	2948	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	3173	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	3246	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5115	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5122	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5132	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5154	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5204	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5344	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5355	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5365	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5385	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5871	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5896	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##		phylum	phylum_no	authorizer	enterer	modifier	
##	233	Hemichordata	33518	Alroy, J.	Sommers, M.	unknown	
##	236	Hemichordata	33518	Alroy, J.	Sommers, M.	unknown	
##	2530	Hemichordata	33518	Holland, S.	Hanson, T.	unknown	
##	2884	Hemichordata	33518	Foote, M.	Foote, M.	unknown	
##	2948	Hemichordata	33518	Foote, M.	Foote, M.	unknown	
##	3173	Hemichordata	33518	Foote, M.	Foote, M.	unknown	
##	3246	Hemichordata	33518	Foote, M.	Foote, M.	unknown	

```
## 5115 Hemichordata 33518 Kiessling, W. Krause, M. unknown
## 5122 Hemichordata 33518 Kiessling, W. Krause, M. unknown
## 5132 Hemichordata 33518 Kiessling, W. Krause, M. unknown
## 5154 Hemichordata 33518 Kiessling, W. Krause, M. unknown
## 5204 Hemichordata 33518 Kiessling, W. Krause, M. unknown
## 5344 Hemichordata 33518 Kiessling, W. Krause, M. unknown
## 5355 Hemichordata 33518 Kiessling, W. Krause, M. unknown
## 5365 Hemichordata 33518 Kiessling, W. Krause, M. Krause, M.
## 5385 Hemichordata 33518 Kiessling, W. Krause, M. Krause, M.
## 5871 Hemichordata 33518 Kroger, B. Kroger, B. unknown
## 5896 Hemichordata 33518 Wagner, P. Wagner, P. unknown
```

```
occGenera <- taxonSortPBDBocc(graptOccPBDB, rank="genus")
occFamily <- taxonSortPBDBocc(graptOccPBDB, rank=("family"))

head(occSpecies)
```

```
## $`Adelograptus antiquus`
##      occurrence_no record_type reid_no obsolete collection_no
## 3609      596430 occurrence      NA      NA      63189
## 3612      596434 occurrence      NA      NA      63190
## 3627      596451 occurrence      NA      NA      63192
## 3630      596454 occurrence      NA      NA      63194
## 3632      596458 occurrence      NA      NA      63195
## 3667      596498 occurrence      NA      NA      63204
## 4223      826761 occurrence      NA      NA      91172
##      identified_name identified_rank identified_no
## 3609 Adelograptus ? antiquus      species      84007
## 3612 Adelograptus ? antiquus      species      84007
## 3627 Adelograptus ? antiquus      species      84007
## 3630 Adelograptus ? antiquus      species      84007
## 3632 Adelograptus ? antiquus      species      84007
## 3667 Adelograptus ? antiquus      species      84007
## 4223 Adelograptus antiquus      species      84007
##      taxonomic_reason      accepted_name accepted_rank accepted_no
## 3609      <NA> Adelograptus antiquus      species      84007
## 3612      <NA> Adelograptus antiquus      species      84007
## 3627      <NA> Adelograptus antiquus      species      84007
## 3630      <NA> Adelograptus antiquus      species      84007
## 3632      <NA> Adelograptus antiquus      species      84007
## 3667      <NA> Adelograptus antiquus      species      84007
## 4223      <NA> Adelograptus antiquus      species      84007
##      early_interval late_interval early_age late_age reference_no
## 3609      Tremadocian Tremadocian 485.4 477.7 18179
## 3612      Lancefieldian Bendigonian 485.4 473.9 18179
## 3627      Lancefieldian Bendigonian 485.4 473.9 18179
## 3630      Tremadocian Tremadocian 485.4 477.7 18179
## 3632      Tremadocian Tremadocian 485.4 477.7 18179
## 3667      Tremadocian Tremadocian 485.4 477.7 18179
## 4223      Ibexian Ibexian 488.3 471.8 24434
##      primary_name primary_reso subgenus_name subgenus_reso species_name
## 3609 Adelograptus      ?      <NA>      <NA>      antiquus
## 3612 Adelograptus      ?      <NA>      <NA>      antiquus
## 3627 Adelograptus      ?      <NA>      <NA>      antiquus
```

```

## 3630 Adelograptus      ?      <NA>      <NA>      antiquus
## 3632 Adelograptus      ?      <NA>      <NA>      antiquus
## 3667 Adelograptus      ?      <NA>      <NA>      antiquus
## 4223 Adelograptus      <NA>      <NA>      <NA>      antiquus
##      species_reso subgenus subgenus_no      genus genus_no family
## 3609      <NA>      NA      NA Adelograptus      33537 <NA>
## 3612      <NA>      NA      NA Adelograptus      33537 <NA>
## 3627      <NA>      NA      NA Adelograptus      33537 <NA>
## 3630      <NA>      NA      NA Adelograptus      33537 <NA>
## 3632      <NA>      NA      NA Adelograptus      33537 <NA>
## 3667      <NA>      NA      NA Adelograptus      33537 <NA>
## 4223      <NA>      NA      NA Adelograptus      33537 <NA>
##      family_no      order order_no      class class_no      phylum
## 3609      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3612      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3627      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3630      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3632      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 3667      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
## 4223      NA Dendroidea      33535 Graptolithina      33534 Hemichordata
##      phylum_no authorizer      enterer      modifier
## 3609      33518      Hendy, A.      Hendy, A.      Hendy, A.
## 3612      33518      Hendy, A.      Hendy, A.      unknown
## 3627      33518      Hendy, A.      Hendy, A.      unknown
## 3630      33518      Hendy, A.      Hendy, A.      Hendy, A.
## 3632      33518      Hendy, A.      Hendy, A.      unknown
## 3667      33518      Hendy, A.      Hendy, A.      unknown
## 4223      33518 Villier, L. Villier, L.      unknown
##
## $`Adelograptus clarki`
##      occurrence_no record_type reid_no obsolete collection_no
## 3610      596431      occurrence      NA      NA      63189
## 3633      596459      occurrence      NA      NA      63195
##      identified_name identified_rank identified_no taxonomic_reason
## 3610 Adelograptus clarki      species      84009      <NA>
## 3633 Adelograptus clarki      species      84009      <NA>
##      accepted_name accepted_rank accepted_no early_interval
## 3610 Adelograptus clarki      species      84009      Tremadocian
## 3633 Adelograptus clarki      species      84009      Tremadocian
##      late_interval early_age late_age reference_no primary_name
## 3610      Tremadocian      485.4      477.7      18179 Adelograptus
## 3633      Tremadocian      485.4      477.7      18179 Adelograptus
##      primary_reso subgenus_name subgenus_reso species_name species_reso
## 3610      <NA>      <NA>      <NA>      clarki      <NA>
## 3633      <NA>      <NA>      <NA>      clarki      <NA>
##      subgenus subgenus_no      genus genus_no family family_no
## 3610      NA      NA Adelograptus      33537 <NA>      NA
## 3633      NA      NA Adelograptus      33537 <NA>      NA
##      order order_no      class class_no      phylum phylum_no
## 3610 Dendroidea      33535 Graptolithina      33534 Hemichordata      33518
## 3633 Dendroidea      33535 Graptolithina      33534 Hemichordata      33518
##      authorizer      enterer      modifier
## 3610      Hendy, A.      Hendy, A.      Hendy, A.
## 3633      Hendy, A.      Hendy, A.      unknown

```

```

##
## $`Amplexograptus rugosus`
##      occurrence_no record_type reid_no obsolete collection_no
## 5893      1256955 occurrence      NA      NA      166800
##      identified_name identified_rank identified_no taxonomic_reason
## 5893 Amplexograptus rugosus      species      315895      <NA>
##      accepted_name accepted_rank accepted_no early_interval
## 5893 Amplexograptus rugosus      species      315895      Longvillian
##      late_interval early_age late_age reference_no primary_name
## 5893 Marshbrookian      457.5      452      102 Amplexograptus
##      primary_reso subgenus_name subgenus_reso species_name species_reso
## 5893      <NA>      <NA>      <NA>      rugosus      <NA>
##      subgenus subgenus_no      genus genus_no family family_no
## 5893      NA      NA Amplexograptus      33615      <NA>      NA
##      order order_no      class class_no      phylum phylum_no
## 5893 Graptoloidea      33606 Graptolithina      33534 Hemichordata      33518
##      authorizer enterer modifier
## 5893 Wagner, P. Wagner, P. unknown
##
## $`Azygograptus novozealandicus`
##      occurrence_no record_type reid_no obsolete collection_no
## 3898      601800 occurrence      NA      NA      63967
## 3960      601885 occurrence      NA      NA      63960
## 3964      601889 occurrence      NA      NA      63961
## 3993      601921 occurrence      NA      NA      63963
## 4014      601945 occurrence      NA      NA      63965
##      identified_name identified_rank identified_no
## 3898      Azygograptus novozealandicus      species      84630
## 3960      Azygograptus novozealandicus      species      84630
## 3964      Azygograptus novozealandicus      species      84630
## 3993 Azygograptus novozealandicus n. sp.      species      84630
## 4014      Azygograptus novozealandicus      species      84630
##      taxonomic_reason      accepted_name accepted_rank
## 3898      <NA> Azygograptus novozealandicus      species
## 3960      <NA> Azygograptus novozealandicus      species
## 3964      <NA> Azygograptus novozealandicus      species
## 3993      <NA> Azygograptus novozealandicus      species
## 4014      <NA> Azygograptus novozealandicus      species
##      accepted_no early_interval late_interval early_age late_age
## 3898      84630      Gisbornian      Gisbornian      460.9      456.1
## 3960      84630      Gisbornian      Gisbornian      460.9      456.1
## 3964      84630      Gisbornian      Gisbornian      460.9      456.1
## 3993      84630      Darriwilian      Darriwilian      467.3      458.4
## 4014      84630      Gisbornian      Gisbornian      460.9      456.1
##      reference_no primary_name primary_reso subgenus_name subgenus_reso
## 3898      18428 Azygograptus      <NA>      <NA>      <NA>
## 3960      18428 Azygograptus      <NA>      <NA>      <NA>
## 3964      18428 Azygograptus      <NA>      <NA>      <NA>
## 3993      18428 Azygograptus      <NA>      <NA>      <NA>
## 4014      18428 Azygograptus      <NA>      <NA>      <NA>
##      species_name species_reso subgenus subgenus_no      genus
## 3898 novozealandicus      <NA>      NA      NA Azygograptus
## 3960 novozealandicus      <NA>      NA      NA Azygograptus
## 3964 novozealandicus      <NA>      NA      NA Azygograptus

```

```

## 3993 novozealandicus      n. sp.      NA      NA Azygograptus
## 4014 novozealandicus      <NA>      NA      NA Azygograptus
##      genus_no family family_no      order order_no      class
## 3898      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 3960      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 3964      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 3993      33628      <NA>      NA Graptoloidea      33606 Graptolithina
## 4014      33628      <NA>      NA Graptoloidea      33606 Graptolithina
##      class_no      phylum phylum_no authorizer      enterer modifier
## 3898      33534 Hemichordata      33518 Hendy, A. Hendy, A. unknown
## 3960      33534 Hemichordata      33518 Hendy, A. Hendy, A. unknown
## 3964      33534 Hemichordata      33518 Hendy, A. Hendy, A. unknown
## 3993      33534 Hemichordata      33518 Hendy, A. Hendy, A. unknown
## 4014      33534 Hemichordata      33518 Hendy, A. Hendy, A. unknown
##
## $`Climacograptus bicornis`
##      occurrence_no record_type reid_no obsolete collection_no
## 2399      246238 occurrence      NA      NA      24117
## 4166      748935 occurrence      NA      NA      80104
## 4320      955088 occurrence      NA      NA      111711
## 4325      955095 occurrence      NA      NA      111713
## 4332      955103 occurrence      NA      NA      111718
## 4516      996584 occurrence      NA      NA      120528
## 4685      1139721 occurrence      NA      NA      145233
## 4695      1139731 occurrence      NA      NA      145236
## 4703      1139741 occurrence      NA      NA      145237
## 4713      1139751 occurrence      NA      NA      145238
## 4725      1139763 occurrence      NA      NA      145240
## 4773      1141828 occurrence      NA      NA      145463
## 4774      1141829 occurrence      NA      NA      145464
## 5330      1144012 occurrence      NA      NA      145615
##      identified_name identified_rank identified_no
## 2399 Climacograptus bicornis      species      306375
## 4166 Climacograptus bicornis      species      306375
## 4320 Climacograptus bicornis      species      306375
## 4325 Climacograptus bicornis      species      306375
## 4332 Climacograptus bicornis      species      306375
## 4516 Climacograptus bicornis      species      306375
## 4685 Climacograptus bicornis      species      306375
## 4695 Climacograptus bicornis      species      306375
## 4703 Climacograptus bicornis      species      306375
## 4713 Climacograptus bicornis      species      306375
## 4725 Climacograptus bicornis      species      306375
## 4773 Climacograptus bicornis      species      306375
## 4774 Climacograptus bicornis      species      306375
## 5330 Climacograptus bicornis      species      306375
##      taxonomic_reason      accepted_name accepted_rank accepted_no
## 2399      <NA> Climacograptus bicornis      species      306375
## 4166      <NA> Climacograptus bicornis      species      306375
## 4320      <NA> Climacograptus bicornis      species      306375
## 4325      <NA> Climacograptus bicornis      species      306375
## 4332      <NA> Climacograptus bicornis      species      306375
## 4516      <NA> Climacograptus bicornis      species      306375
## 4685      <NA> Climacograptus bicornis      species      306375

```


##	4695	<NA>	Climacograptus	bicornis	species	306375	
##	4703	<NA>	Climacograptus	bicornis	species	306375	
##	4713	<NA>	Climacograptus	bicornis	species	306375	
##	4725	<NA>	Climacograptus	bicornis	species	306375	
##	4773	<NA>	Climacograptus	bicornis	species	306375	
##	4774	<NA>	Climacograptus	bicornis	species	306375	
##	5330	<NA>	Climacograptus	bicornis	species	306375	
##		early_interval	late_interval	early_age	late_age	reference_no	
##	2399	Trentonian	Richmondian	460.9	443.7	6817	
##	4166	Idavere	Idavere	460.9	455.8	26936	
##	4320	Late Ordovician	Late Ordovician	458.4	443.4	36540	
##	4325	Late Ordovician	Late Ordovician	458.4	443.4	36540	
##	4332	Late Ordovician	Late Ordovician	458.4	443.4	36540	
##	4516	Sandbian	Sandbian	458.4	453.0	38521	
##	4685	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4695	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4703	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4713	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4725	Gisbornian	Gisbornian	460.9	456.1	46966	
##	4773	Eastonian	Eastonian	456.1	449.5	46966	
##	4774	Eastonian	Eastonian	456.1	449.5	46966	
##	5330	Caradocian	Caradocian	460.9	449.5	47089	
##		primary_name	primary_reso	subgenus_name	subgenus_reso	species_name	
##	2399	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4166	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4320	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4325	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4332	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4516	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4685	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4695	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4703	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4713	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4725	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4773	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	4774	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##	5330	Climacograptus	<NA>	<NA>	<NA>	bicornis	
##		species_reso	subgenus	subgenus_no	genus	genus_no	
##	2399	<NA>	NA	NA	Climacograptus	33636	
##	4166	<NA>	NA	NA	Climacograptus	33636	
##	4320	<NA>	NA	NA	Climacograptus	33636	
##	4325	<NA>	NA	NA	Climacograptus	33636	
##	4332	<NA>	NA	NA	Climacograptus	33636	
##	4516	<NA>	NA	NA	Climacograptus	33636	
##	4685	<NA>	NA	NA	Climacograptus	33636	
##	4695	<NA>	NA	NA	Climacograptus	33636	
##	4703	<NA>	NA	NA	Climacograptus	33636	
##	4713	<NA>	NA	NA	Climacograptus	33636	
##	4725	<NA>	NA	NA	Climacograptus	33636	
##	4773	<NA>	NA	NA	Climacograptus	33636	
##	4774	<NA>	NA	NA	Climacograptus	33636	
##	5330	<NA>	NA	NA	Climacograptus	33636	
##		family	family_no	order	order_no	class	class_no
##	2399	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534

##	4166	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4320	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4325	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4332	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4516	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4685	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4695	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4703	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4713	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4725	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4773	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	4774	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5330	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##		phylum	phylum_no	authorizer	enterer	modifier	
##	2399	Hemichordata	33518	Holland, S.	Hanson, T.	unknown	
##	4166	Hemichordata	33518	Novack-Gottshall, P.	Hearn, P.	Wagner, P.	
##	4320	Hemichordata	33518	Miller, A.	Kolbe, S.	Kolbe, S.	
##	4325	Hemichordata	33518	Miller, A.	Kolbe, S.	unknown	
##	4332	Hemichordata	33518	Miller, A.	Kolbe, S.	unknown	
##	4516	Hemichordata	33518	Kiessling, W.	Merkel, U.	unknown	
##	4685	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4695	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
##	4703	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4713	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4725	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##	4773	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
##	4774	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
##	5330	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
##							
##		\$`Climacograptus scalaris`					
##		occurrence_no	record_type	reid_no	obsolete	collection_no	
##	233	41894	occurrence	NA	NA	3281	
##	236	41899	occurrence	NA	NA	3282	
##	2530	260374	occurrence	NA	NA	25168	
##	2884	285928	occurrence	NA	NA	27197	
##	2948	287240	occurrence	NA	NA	27388	
##	3173	291182	occurrence	NA	NA	27782	
##	3246	292390	occurrence	NA	NA	27838	
##	5115	1143763	occurrence	NA	NA	145587	
##	5122	1143780	occurrence	NA	NA	145589	
##	5132	1143790	occurrence	NA	NA	145590	
##	5154	1143812	occurrence	NA	NA	145591	
##	5204	1143865	occurrence	NA	NA	145598	
##	5344	1144116	occurrence	NA	NA	145653	
##	5355	1144128	occurrence	NA	NA	145654	
##	5365	1144142	occurrence	NA	NA	145655	
##	5385	1144162	occurrence	NA	NA	145656	
##	5871	1218886	occurrence	NA	NA	159343	
##	5896	1257991	occurrence	NA	NA	166909	
##		identified_name	identified_rank	identified_no			
##	233	Climacograptus scalaris	species	316364			
##	236	Climacograptus scalaris	species	316364			
##	2530	Climacograptus scalaris	species	316364			
##	2884	Climacograptus scalaris	species	316364			

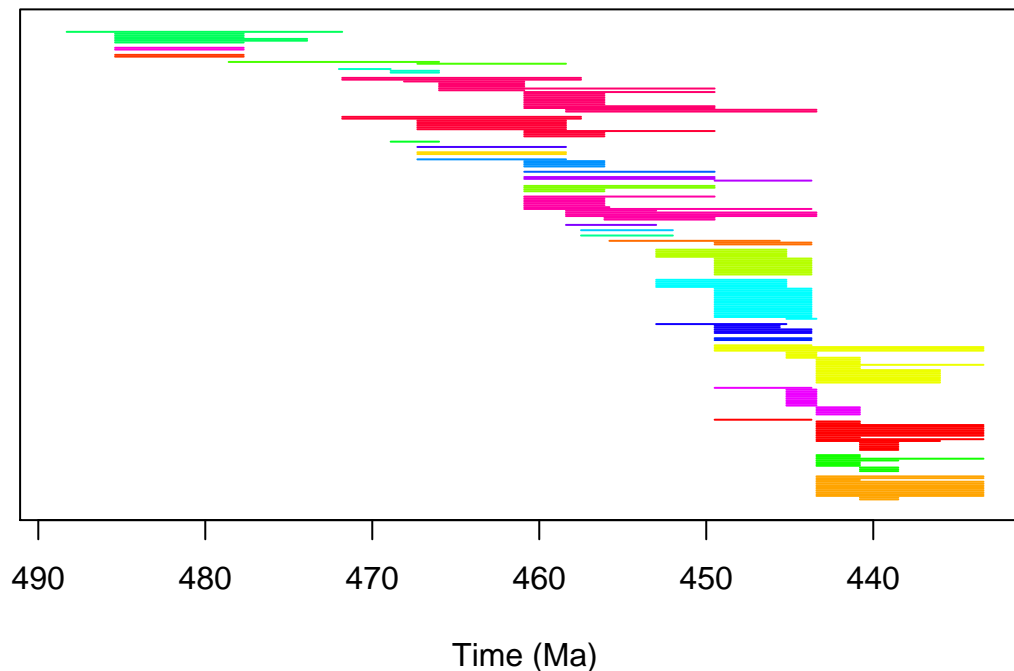
##	2948	Climacograptus	scalaris	species	316364	
##	3173	Climacograptus	scalaris	species	316364	
##	3246	Climacograptus	scalaris	species	316364	
##	5115	Climacograptus	scalaris	species	316364	
##	5122	Climacograptus ?	scalaris	species	316364	
##	5132	Climacograptus	scalaris	species	316364	
##	5154	Climacograptus	scalaris	species	316364	
##	5204	Climacograptus	scalaris	species	316364	
##	5344	Climacograptus	scalaris	species	316364	
##	5355	Climacograptus	scalaris	species	316364	
##	5365	Climacograptus	scalaris	species	316364	
##	5385	Climacograptus	scalaris	species	316364	
##	5871	Climacograptus	scalaris	species	316364	
##	5896	Climacograptus	scalaris	species	316364	
##		taxonomic_reason	accepted_name	accepted_rank	accepted_no	
##	233	<NA>	Climacograptus scalaris	species	316364	
##	236	<NA>	Climacograptus scalaris	species	316364	
##	2530	<NA>	Climacograptus scalaris	species	316364	
##	2884	<NA>	Climacograptus scalaris	species	316364	
##	2948	<NA>	Climacograptus scalaris	species	316364	
##	3173	<NA>	Climacograptus scalaris	species	316364	
##	3246	<NA>	Climacograptus scalaris	species	316364	
##	5115	<NA>	Climacograptus scalaris	species	316364	
##	5122	<NA>	Climacograptus scalaris	species	316364	
##	5132	<NA>	Climacograptus scalaris	species	316364	
##	5154	<NA>	Climacograptus scalaris	species	316364	
##	5204	<NA>	Climacograptus scalaris	species	316364	
##	5344	<NA>	Climacograptus scalaris	species	316364	
##	5355	<NA>	Climacograptus scalaris	species	316364	
##	5365	<NA>	Climacograptus scalaris	species	316364	
##	5385	<NA>	Climacograptus scalaris	species	316364	
##	5871	<NA>	Climacograptus scalaris	species	316364	
##	5896	<NA>	Climacograptus scalaris	species	316364	
##		early_interval	late_interval	early_age	late_age	reference_no
##	233	Aeronian	Aeronian	440.8	438.5	155
##	236	Aeronian	Aeronian	440.8	438.5	155
##	2530	Alexandrian	Alexandrian	443.4	436.0	7063
##	2884	Llandovery	Llandovery	443.4	433.4	7455
##	2948	Rhuddanian	Rhuddanian	443.4	440.8	7455
##	3173	Llandovery	Llandovery	443.4	433.4	7624
##	3246	Llandovery	Llandovery	443.4	433.4	7624
##	5115	Llandovery	Llandovery	443.4	433.4	47076
##	5122	Llandovery	Llandovery	443.4	433.4	47076
##	5132	Llandovery	Llandovery	443.4	433.4	47076
##	5154	Llandovery	Llandovery	443.4	433.4	47076
##	5204	Llandovery	Llandovery	443.4	433.4	47083
##	5344	Rhuddanian	Rhuddanian	443.4	440.8	47103
##	5355	Rhuddanian	Rhuddanian	443.4	440.8	47103
##	5365	Aeronian	Aeronian	440.8	438.5	47103
##	5385	Aeronian	Aeronian	440.8	438.5	47103
##	5871	Aeronian	Aeronian	440.8	438.5	52096
##	5896	Bolindian	Bolindian	449.5	443.7	78
##		primary_name	primary_reso	subgenus_name	subgenus_reso	species_name
##	233	Climacograptus	<NA>	<NA>	<NA>	scalaris

##	236	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	2530	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	2884	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	2948	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	3173	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	3246	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5115	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5122	Climacograptus	?	<NA>	<NA>	scalaris	
##	5132	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5154	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5204	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5344	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5355	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5365	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5385	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5871	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##	5896	Climacograptus	<NA>	<NA>	<NA>	scalaris	
##		species_reso	subgenus	subgenus_no	genus	genus_no	
##	233	<NA>	NA	NA	Climacograptus	33636	
##	236	<NA>	NA	NA	Climacograptus	33636	
##	2530	<NA>	NA	NA	Climacograptus	33636	
##	2884	<NA>	NA	NA	Climacograptus	33636	
##	2948	<NA>	NA	NA	Climacograptus	33636	
##	3173	<NA>	NA	NA	Climacograptus	33636	
##	3246	<NA>	NA	NA	Climacograptus	33636	
##	5115	<NA>	NA	NA	Climacograptus	33636	
##	5122	<NA>	NA	NA	Climacograptus	33636	
##	5132	<NA>	NA	NA	Climacograptus	33636	
##	5154	<NA>	NA	NA	Climacograptus	33636	
##	5204	<NA>	NA	NA	Climacograptus	33636	
##	5344	<NA>	NA	NA	Climacograptus	33636	
##	5355	<NA>	NA	NA	Climacograptus	33636	
##	5365	<NA>	NA	NA	Climacograptus	33636	
##	5385	<NA>	NA	NA	Climacograptus	33636	
##	5871	<NA>	NA	NA	Climacograptus	33636	
##	5896	<NA>	NA	NA	Climacograptus	33636	
##		family	family_no	order	order_no	class	class_no
##	233	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	236	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	2530	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	2884	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	2948	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	3173	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	3246	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5115	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5122	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5132	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5154	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5204	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5344	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5355	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5365	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5385	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	5871	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534

## 5896	Diplograptidae	150197	Graptoloidea	33606	Graptolithina	33534
##	phylum	phylum_no	authorizer	enterer	modifier	
## 233	Hemichordata	33518	Alroy, J.	Sommers, M.	unknown	
## 236	Hemichordata	33518	Alroy, J.	Sommers, M.	unknown	
## 2530	Hemichordata	33518	Holland, S.	Hanson, T.	unknown	
## 2884	Hemichordata	33518	Foote, M.	Foote, M.	unknown	
## 2948	Hemichordata	33518	Foote, M.	Foote, M.	unknown	
## 3173	Hemichordata	33518	Foote, M.	Foote, M.	unknown	
## 3246	Hemichordata	33518	Foote, M.	Foote, M.	unknown	
## 5115	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
## 5122	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
## 5132	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
## 5154	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
## 5204	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
## 5344	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
## 5355	Hemichordata	33518	Kiessling, W.	Krause, M.	unknown	
## 5365	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
## 5385	Hemichordata	33518	Kiessling, W.	Krause, M.	Krause, M.	
## 5871	Hemichordata	33518	Kroger, B.	Kroger, B.	unknown	
## 5896	Hemichordata	33518	Wagner, P.	Wagner, P.	unknown	

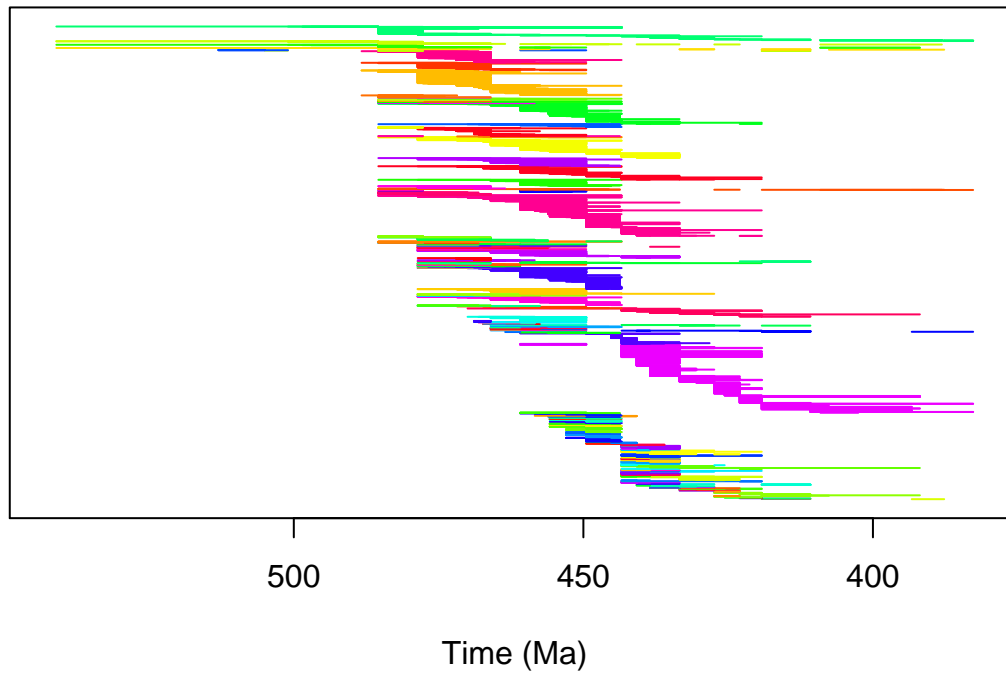
```
plotOccData(occSpecies, groupLabel = "Species")
```

Age Uncertainty of Occurrence Data for Species



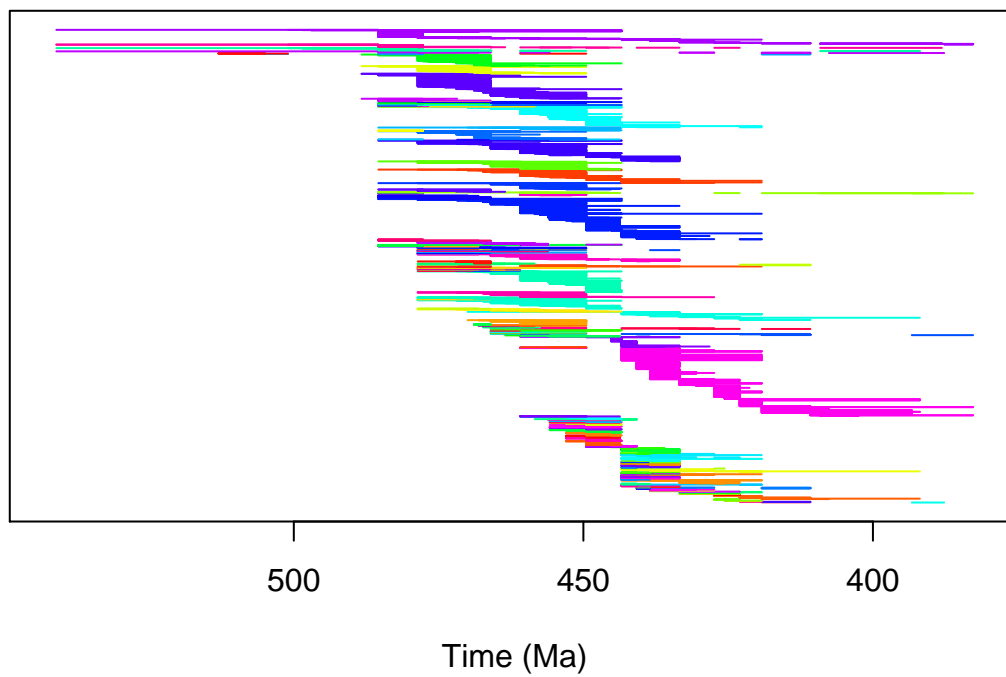
```
plotOccData(occGenera, groupLabel = "Genera")
```

Age Uncertainty of Occurrence Data for Genera



```
plotOccData(occGenera, groupLabel = "Families")
```

Age Uncertainty of Occurrence Data for Families



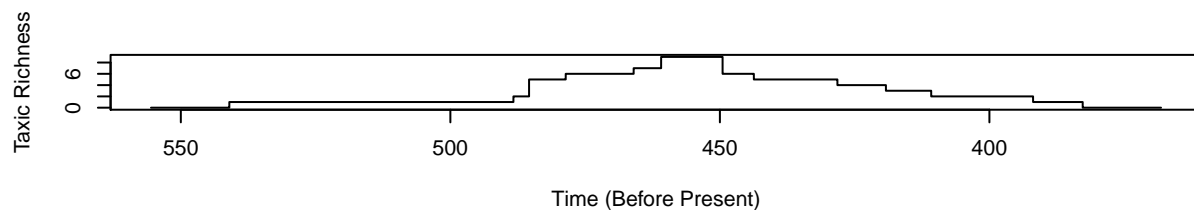
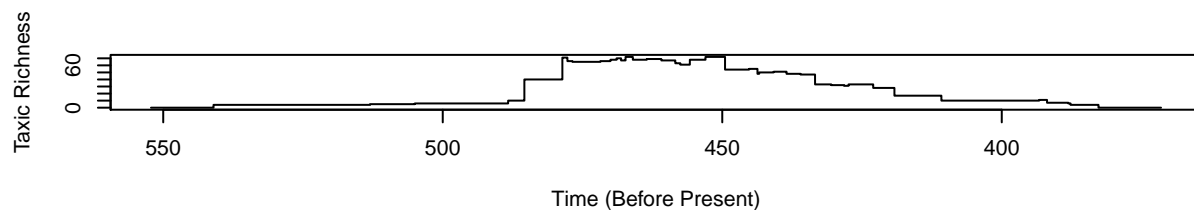
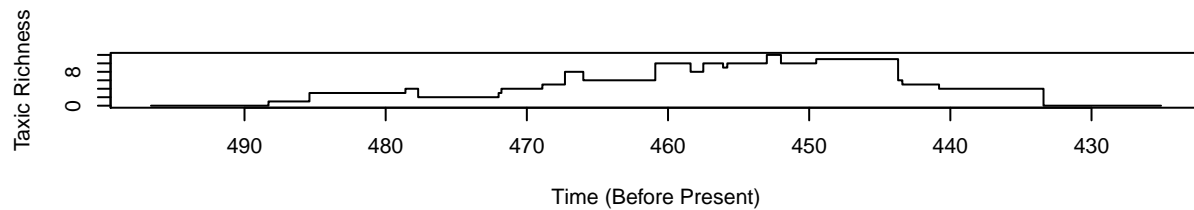
```
pdf(file= "ranges.pdf")
plotOccData(occSpecies,groupLabel = "Species")
plotOccData(occGenera, groupLabel = "Genera")
plotOccData(occGenera, groupLabel = "Families")
dev.off()
```

```
## pdf
## 2
```

Now lets look at the diversity through time for various ranks

```
graptTimeSpecies<-occData2timeList(occList=occSpecies)
graptTimeGenus<-occData2timeList(occList=occGenera)
graptTimeFamily<-occData2timeList(occList=occFamily)
```

```
layout(1:3)
taxicDivDisc(graptTimeSpecies)
taxicDivDisc(graptTimeGenus)
taxicDivDisc(graptTimeFamily)
```



```
dev.off()
```

```
## null device
## 1
```

```
pdf(file="dtb.pdf")
taxicDivDisc(graptTimeSpecies)
taxicDivDisc(graptTimeGenus)
taxicDivDisc(graptTimeFamily)
dev.off()
```

```
## null device
##          1
```

We can use the paleobioDB package to directly query the PBDB and work with data. Try repeating the analyses above with the canid data set.

```
library(paleobioDB)

canids <- pbdb_occurrences (limit="all", vocab= "pbdb", base_name="Canidae", show=c('phylo', 'ident'))
head(canids)
```

```
##      occurrence_no record_type collection_no      taxon_name
## 1:1      117266  occurrence      9070  Cynodictis lacustris
## 1:2      150070  occurrence      13293      Cuon sp.
## 1:3      176227  occurrence      16626  Hesperocyon sp.
## 1:4      176384  occurrence      16647  Miacis washakius
## 1:5      177551  occurrence      16840  Hesperocyon ? sp.
## 1:6      177611  occurrence      16845 Hesperocyon gregarius cf.
##      taxon_rank taxon_no      matched_name matched_rank matched_no
## 1:1      species  349281 Cynodictis lacustris      species      349281
## 1:2      genus   41204      Cuon      genus      41204
## 1:3      genus   41217      Hesperocyon      genus      41217
## 1:4      species  48498 Neovulpavus washakius      species      49147
## 1:5      genus   41217      Hesperocyon      genus      41217
## 1:6      species  46911 Hesperocyon gregarius      species      46911
##      early_interval early_age late_age reference_no      genus
## 1:1      Late Eocene  37.200  33.9000  11154;11154  Cynodictis
## 1:2 Middle Pleistocene  0.781  0.0117  4412;4412      Cuon
## 1:3      Late Uintan  46.200  40.4000  1139;1139 Hesperocyon
## 1:4      Uintan      46.200  40.4000  2495;2495 Neovulpavus
## 1:5      Duchesnean  40.400  33.9000  3359;3359 Hesperocyon
## 1:6      Duchesnean  40.400  37.2000  6226;6226 Hesperocyon
##      genus_no family family_no      order order_no      class class_no
## 1:1      41276 Canidae  41189 Carnivora  36905 Mammalia  36651
## 1:2      41204 Canidae  41189 Carnivora  36905 Mammalia  36651
## 1:3      41217 Canidae  41189 Carnivora  36905 Mammalia  36651
## 1:4      49146 Canidae  41189 Carnivora  36905 Mammalia  36651
## 1:5      41217 Canidae  41189 Carnivora  36905 Mammalia  36651
## 1:6      41217 Canidae  41189 Carnivora  36905 Mammalia  36651
##      phylum phylum_no genus_name species_name      late_interval reid_no
## 1:1 Chordata  33815 Cynodictis lacustris      <NA>      NA
## 1:2 Chordata  33815      Cuon      sp. Late Pleistocene      NA
## 1:3 Chordata  33815 Hesperocyon      sp.      <NA>      3083
## 1:4 Chordata  33815      Miacis washakius      <NA>      NA
## 1:5 Chordata  33815 Hesperocyon      sp.      Chadronian      NA
## 1:6 Chordata  33815 Hesperocyon gregarius      <NA>      3336
```


##	genus_reso	species_reso	subgenus_name	subgenus_reso
## 1:1	<NA>	<NA>	<NA>	<NA>
## 1:2	<NA>	<NA>	<NA>	<NA>
## 1:3	<NA>	<NA>	<NA>	<NA>
## 1:4	<NA>	<NA>	<NA>	<NA>
## 1:5	?	<NA>	<NA>	<NA>
## 1:6	<NA>	cf.	<NA>	<NA>

How would you repeat the analyses?