



# Hdb2Win 2.5.1

Application Library PaleoTax  
Analysis of the database  
Edition SR17 (May 2022)

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## Introduction

### *General*

This document describes the programmes for data analysis and estimation of the Hdb2Win Application Library PaleoTax, Service Release 17. Analysing programmes for other Application Libraries (PalCol, Oliva) are described in other documents. Analysing programmes are found behind the button **Programmes** in the menu after opening a database. Some of the programmes are modifying data of the database but only in data fields that were exclusively created for this purpose.

### *History*

Data analysis and estimation is an important part of the Hdb2Win Application Library PaleoTax. In former versions of the Application Library (up to SR15) various programmes were offered through the button **Analysis**. These programmes used an external graphic library that does not work anymore with more recent versions of the operating system. In Hdb2Win 2.5 (PaleoTax SR16) the function and the programmes were removed and are now with SR17 replaced by improved programmes that uses the graphic library of PaleoTax/Graph. Most programmes described here have the same number as in former versions. Some programmes were added, and more will be added in the future.

### *Output*

The difference to the former version is that the results are displayed as graphs with PaleoTax/Graph. All programmes create a corresponding ANSI file with the extension PGR. Some programmes produce a data file that can be imported into any spreadsheet or statistic programme.

### *PaleoTax/Graph*

PaleoTax/Graph is a on the one hand a stand-alone programme of the 'PaleoTax family' but also a plug-in in Hdb2Win. When an analysis was successful executed and there are data available, the plug-in is started automatically and the resulting graph is shown.

Most PGR files includes predefined (optimal) settings for PaleoTax/Graph. Of course you will be able to modify these settings (such as the paper format, margins, fonts, colours) in the programme PaleoTax/Graph. For details compare to the separate manual for PaleoTax/Graph.

PaleoTax/Graph produces files in the WMF format. This is a small and versatile vector format that can easily be imported by other applications (text processor, vector graphic editor, Hdb2Win). If you experience problems importing a file, mark in PaleoTax/Graph under 'Paper format and margins' the box 'Avoid FillRect' and try again. The image shown in the preview may look strange, but you never get what you see. Generally the preview looks worse than the resulting file.

### *Data analysis*

Data analysis in the application library PaleoTax has various aspects.

#### *Richness*

Richness or abundance describes the amount of taxa or localities that have a range during a certain time span. Ranges of taxa (species, genera, families) and localities are be summarised over time and result in an richness or abundance curve. Taxa and localities have a range in time. This range can be long or short. For data analysis, localities with long ranges can be suppressed since these long ranges ('Cretaceous', 'Paleozoic') are only noise. The best value for the restriction is the range of the longest stage in the studied time interval. Ranges of species are either calculated on the base of their occurrence on localities or are critical ranges. Genera ranges are calculated on the base of species or are critical ranges. Same for families etc. The range of a taxon or a locality starts and ends at a boundary in time. The upper value can be zero if the taxon is still persistent or the locality is recent. A recent locality must have a lower age boundary which value is different from zero; it could be one thousand years as for instance. Localities with an age where the lower boundary is zero, are not included. To obtain an abundance curve, the quantity of localities and taxa that existed in the same time interval are summarised (see Fig. 5).

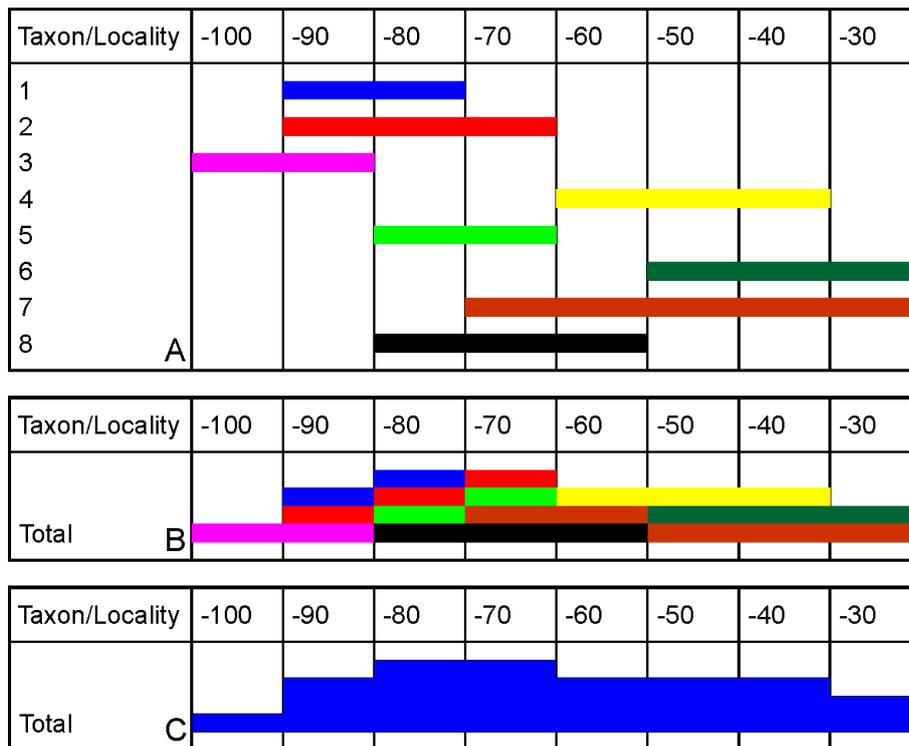


Figure 1. Calculation of the richness of taxa or localities per time slice from ranges: A, ranges of taxa or localities; B, summarising the ranges; C, converting into a polygon.

For summarising taxa the programmes offer various options. As for instance, species in open nomenclature or species endemic to one locality can be suppressed. Monospecific genera can be suppressed.

Richness diagrams may have two different forms, a diagram with one or several curves or polygons that deals with all taxa, or a chart where the richness of various taxa is shown (as for instance species of one genus, or genera of one family). Charts are principally produced by reports (Search menu in the application library of PaleoTax; SPECIES and GENERA tables).

#### *Correlation with time-related data*

Correlation with time-related data (number of anoxic events, sea level, temperature, etc.) can be correlated with the richness of taxa. This show probable positive or negative correlation with environmental conditions.

#### *Correlation of taxa or localities*

Taxa can be correlated based on their occurrence in localities, region, palaeogeographic units etc., and localities, regions, time spans, palaeogeographic units etc can be correlated based on the taxa. For the correlation various correlation coefficients are available. For the science behind these coefficients please compare to Cheetham & Hazel (1969).

#### *Numerical reference file*

Most programmes require a numerical reference file. This file is for most programmes necessary and in all programmes it helps in structuring the images. If no file is selected the file provided with the Application Library PaleoTax (STANDARD.PSC) is used, but it represents more an example than a version you can work with.

The correct reference file can be easily created with the PaleoTax Application Library (table AGE BOUNDARIES) but need in most cases to be adapted by hand. When you create your own PaleoTax database and you want to estimate data, you need to build up a stratigraphical framework. This framework is based on the geological times scale (GTS) that is regularly published. Normally you would work with the newest version and update values when a new version is published. The GTS defines the absolute ages of the age boundaries.

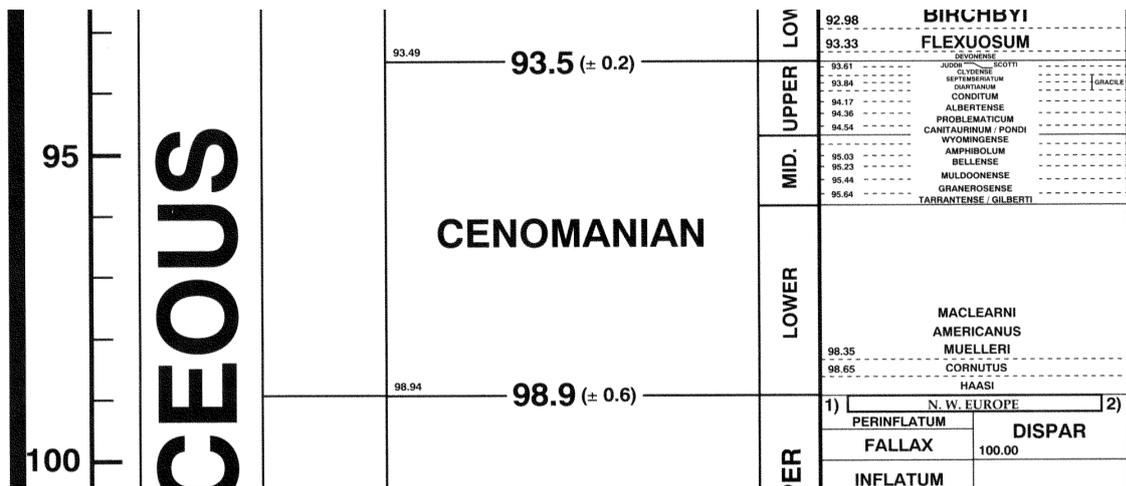


Figure 2. Example of a geological times scale. The numbers refer to absolute time. Taken from Hardenbol et al. (1998).

These absolute values enter in the table of AGE BOUNDARIES (AGEIUGS). It makes much sense to start to build up this table before entering locality data with their stratigraphy, at least with some rough data. The table AGE BOUNDARIES has also two fields behind the text Numerical reference (PSC). The left field (Show with text) should be marked when dealing with stage boundaries plus sub-stages (when the observed time span is short). The right field (Include in data estimation) should be tagged for stages, sub-stages and probably also bio-zones (if the time span is short), but not for sub-zones.

Figure 3. Data acquisition form of the table AGE BOUNDARIES from SR17 on.

It depends on your stratigraphical frame. These tags are more important for visualisation, less for the estimation. As for instance, if you work in the whole Jurassic and also include ammonite bio-zones boundaries in the estimation, the results are not well visible in the output and may cause a data overflow. When in contrary you are working only in the Albian to Cenomanian (which is a much shorter time span), you should clearly include bio-zones boundaries in the data estimation. The total number of records marked with 'Show with text' should be between 10 and 20, and the number of fields marked as 'Include in data estimation' between 20 and 40.

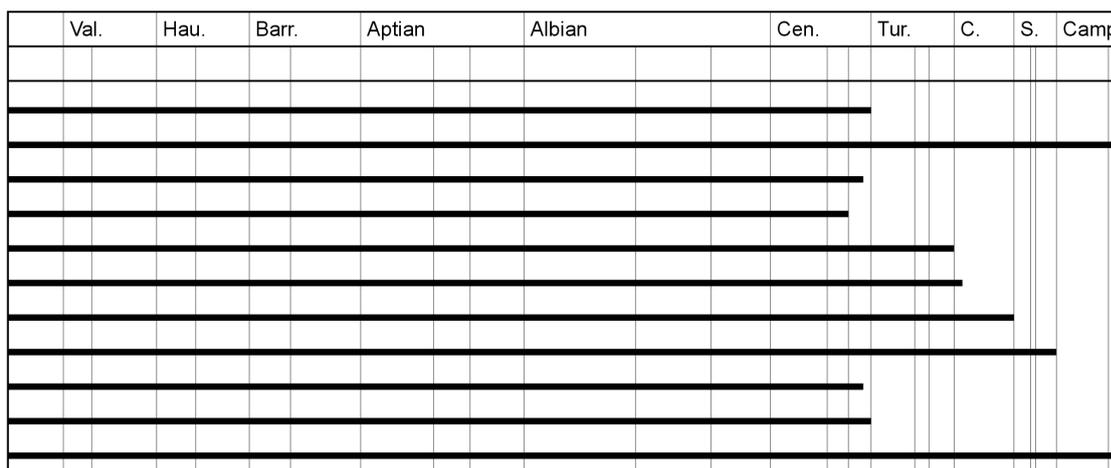


Figure 4. PaleoTax/Graph Chart with two head lines. Only those lines reach to top of the frame and have a describing text where records were marked as 'Show with text'. Those records that are not tagged but tagged with 'Include in data estimation' are only shown as a line the reach the second head line. In this example only stages have a text, and sub-stages (except Coniacian) are shown as lines. As you can see, the width of the columns is related to the duration of the stages.

Campanian		-83.5
	FF00FF	
-	-84.6	
-	-84.88	
S.	-85.8	CA
C.	-89	FF
-	-90.36	2867FB
-	-91.12	
Tur.	-93.5	
-	-94.71	
-	-95.84	
Cen.	-98.9	FFFF
-	-102.12	40FF00
-	-106.18	DF00
Albian	-112.2	408000
-	-115.11	
-	-117.07	FFACAC
Aptian	-121	FF7979
-	-124.76	
Barr.	-127	FF4A4A
-	-129.89	
Hau.	-132	FF0000
-	-135.5	
Val.	-137	A00000
-	-140.05	
-	-142.03	
Berr.	-144.2	800000

Figure 5. Corresponding part in the Numerical reference file used for figure 3. Text and value are separated by a tabulator. Colours are optional.

The distance between the values is important to obtain an equilibrated graph of the estimated data. The numerical reference file has much more to do with the creating of the graphs than with data estimation.

When once a stratigraphical frame work is set up in your database, it is possible to create a numerical reference file. Open the database, select the AGE BOUNDARIES table, select all records, choose Report : Numerical reference, click on **Output** and edit the resulting file. Rename the file but do not change the extension PSC.

### **Critical ranges**

In both tables GENERA and SPECIES there are two options for the ranges of the taxa. On the one hand they can be calculated based on the localities (as for SPECIES) or species (as for GENERA), and on the other hand they can be set manually by the person who administrates the database.

First occurrence	:	Hauterivian, base	to :	Middle Albian, base
Crit. stratigraphy	:	Aptian, base	to :	Middle Albian, base

Figure 6. Calculated ranges (in red) and critical ranges (in black).

Ranges calculated are shown in the red colour. The calculation of this ranges is realised by the programme PTXEST17.PRF (see below).

### *Options*

Most programmes offer multiple options for the data analysis. All the selected options are stored on the Hdb2Win Registry (c:\Users\\AppData\ Roaming\Hdb2Win\ Hdb2WinRegistry.txt for Windows from version 7 on or C:\Documents and settings\\AppData\ Hdb2Win\ Hdb2WinRegistry.txt for Windows XP). Important settings are shown in the graph in a box in the upper left corner.

Open determinations (sp.) are suppressed Species : Calculated ranges Genera : Critical ranges Numerical reference : E:\BASE\FCNIES98.PSC
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Figure 7. Options in separate box.

### *Advice for data analysis*

In some tables (SPECIES, GENERA, LOCALITIES) exist data field in a red text colour. The content of this field is set by applying the principal data analyse and estimation programme PTXEST17.PRF. This programme can be find behind the button **Programmes** with the description ‘Standard estimation of the database (SR17)’. This programme is described below (General estimation of the database). Some further analysis expect data created by this programme.

Data analysis makes only sense of the amount of data is representative for the investigated area. Incomplete and/or inexact data in your database produces equivalent results.

## Description of programmes

### *General estimation of the database*

The programme for the general estimation of the database (PTXEST17.PRF; Standard estimation of the database (SR17)) should be called from within the database (button **Programmes**). The programme is important for further data analysis and estimation programmes. Various of the below described programmes expect data that are provided by PTXEST17.PRF.

It does not make much sense apply the programme to an empty database or a database with very few data. The table of OCCURRENCES must have at least 100 records. It is possible to select estimations but it is recommended to use all. For some estimations there are additional options.

Stratigraphy of species - Calculates the ranges of the species from the occurrences.

There are various options

1. Pay attention to field "Suppress locality" in Localities - Localities that are suppressed are not included in the analysis.
2. Pay attention to field "Suppress citation" in citations - Suppressed citations are not included.
3. Suppress indications without description/illustration - Citations that are only listed and that have no description and/or illustration are not included.
4. Suppress open determinations (sp.) - Species having 'sp.' as species name, are suppressed.
5. Set limit for the age of localities (ma) - Very important option. It is possible to exclude localities with a very long range. A locality with the age 'Cretaceous' only blurs the results. It is a good method to put here the length of the longest stage within the stratigraphic framework of your area.

Stratigraphy of genera - Calculates the ranges of the genera from the species.

The results depends much on the previous calculation. So the options for the stratigraphy of species have a direct influence in the Stratigraphy of the genera.

Localities : number of species and citations

... do not count synonym species

Counts the number of species and citations. Synonym species can be suppressed marking the second box.

Age boundaries : number of species and genera

Counts the number of genera and species for each age boundary. First, last, and all boundaries in between are counted.

Species : number of citations

Counts the number of citations.

Genera : number of species

Counts the number of species.

Publications : number of citations

Counts the number of citations.

### ***001 Abundance of genera***

Description : The abundance is the amount of genera the co-existed during a certain time span. This value is obtained by summarising the ranges of the genera over time. Calculated or critical ages can be used.

Displayed as : 001 Abundance of genera based on (critical) ranges

Programme : PTXES001.PRF

Output chart : ES001.PGR

#### Conditions

GENERA table must have at least 10 records and must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. Ranges must be calculated (Standard estimation of the database 2.2) or set manually. A numerical reference file must be available, but can be also created automatically.

#### Options

1. Use the data calculated on the range of species (= from the localities of the citations).
2. Use the critical data in the GENERA table recorded by the user.

It is recommendable to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

- E1 Less than ten records in the GENERA table.
- E2 There are no range data at all.
- E3 No data for output are found.

## 002 Abundance of species

- Description : The abundance is the amount of genera the co-existed during a certain time span. This value is obtained by summarising the ranges of the genera over time. Calculated or critical ages can be used.
- Displayed as : 002 Abundance of species based on (critical) ranges
- Programme : PTXES002.PRF
- Output chart : ES002.PGR

### Conditions

SPECIES table must have at least 10 records and must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. Ranges must be calculated (Standard estimation of the database 2.2) or set manually. A numerical reference file must be available, but can be also created automatically.

### Options

1. Use either the data calculated from the localities of the citations ...
2. ... or use the critical data in the SPECIES table recorded by the user. Only one option should be selected.
3. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table Species is 'sp.'. The absence of an author is not anymore considered as open taxonomy.

It is recommendable to select a numerical reference file.

### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

- E1 Less than ten records in the SPECIES table.
- E3 There are no range data at all.
- E4 No data for output are found.

### ***003 Abundance of localities***

Description : The abundance is the sum of ranges of localities.  
Displayed as : 003 Abundance of localities  
Programme : PTXES003.PRF  
Output chart : ES003.PGR

#### Conditions

LOCALITY table must have at least 10 records and must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

1. Set limit for the age of localities (ma) - Localities with a imprecise stratigraphy (e.g. very long ranges) can be excluded from the analysis. Set the limit in million years.
2. Count only localities with species (field *lospec* in the LOCALITY table must be different from zero). - This is recommended if localities were recorded without indications, or PaleoTax is used to record various organism groups using the pooling option.

It is recommendable to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

- E1 Less than ten records in the LOCALITY table.
- E2 Age data are invalid.
- E3 There are no range data at all.
- E4 No data for output are found.

### 005 *Species and locality abundance*

Description	: Species and locality abundance correspond to the number of co-existing species and localities. The values are calculated based on the ranges of species and localities. You will note a strong correlation: a large outcrop area (= many localities) generates more species and species records.
Displayed as	: 005 Species abundance, locality abundance and sa divided by la
Programme	: PTXES005.PRF
Output data	: ES005.DAT
Output chart	: ES005.PGR

#### Conditions

OCCURRENCE table must have at least 100 records. Localities must have ages and ages must have lower and upper limit. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

##### (1) General options

1. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table Species is 'sp.'. The absence of an author is not anymore considered as open taxonomy.
2. Check field *lsuppress* in LOCALITY - Localities where the field *lsuppress* is marked are excluded from the analysis.
3. Set limit for the age of localities (ma) - Localities with an imprecise stratigraphy (e.g. very long ranges) can be excluded from the analysis. Set the limit in million years.
4. Comma instead of decimal point in output - Comma is used instead of point in the data output.
5. Calculate SA\*10/LA instead of SA/LA (output) - If the amount of data is low, it is difficult to see a trend, when the species abundance (SA) is divided by the locality abundance (LA).
6. Count only localities (LA) with indications - This is recommended if localities were recorded without indications, or PaleoTax is used to record various organism groups using the pooling option.
7. Suppress indications without description/illustration - Only listed quotations are not included.
8. Take care of the field "Include in data estimation" in the AGEIUGS table - Only those records in the table AGE BOUNDARIES are included in the analysis where the field "Include in data estimation" are marked.

It is recommendable to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is lower than the bottom value in the table AGES, or both have the same value.

#### Remarks

Species abundance : Number of indications according to the time (refers to age boundaries)

Locality abundance : Number of localities according to the time (refers to age boundaries)

SA divided by LA : is the value high, the number of species per locality is high. Normally both SA and LA correlate.

## ***006 Evolution of Genera***

Description : Numerical development of genera which originated in a specified time interval. The graph shows the success of genera originated in a certain time interval.

Displayed as : 006 Evolution of Genera

Programme : PTXES006.PRF

Output chart : ES006.PGR

### Conditions

GENERA and AGE BOUNDARIES tables must have at least 10 records. Genera must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be present, that will be created by the programme.

### Options

(1) The first option defines which data are used:

1. Use the data calculated on the range of species (= from the localities of the citations).
2. Use the critical data in the GENERA table recorded by the user.

(2) The second option requests which time raster should be used.

1. Records in AGE BOUNDARIES where "Show with text" is marked
2. Records in AGE BOUNDARIES where "Include in data estimation" is marked
3. Manual selection of records - The manual selection opens a table with the records from the AGE BOUNDARIES table. You can select and deselect records by pressing F8. Selected records are marked with an asterisk (\*) in the field of the record number. Finish with F10. The selection is kept in a file with the extension REC and the same records will be marked when the programme is executed again.
4. According to a numerical reference file - In this file you need to select a numerical reference file.

In the first three cases, a temporal numerical reference file (TEMP006.PSC) is created. The numerical reference file should cover the whole range of all the considered. So it is better to construct this file from the complete table of AGE BOUNDARIES. If the numerical reference does not have enough items, the programmed will not be executed.

(3) The third option offer to limit the genera to a certain time span.

If a person is working with Mesozoic gastropods but want to see only the evolution of the Jurassic genera (genera that reached the Jurassic or have their origin in the Jurassic) should limit the estimation to this time.

### Remarks

The graph shows the success of genera that occurred during a specific time span (see image below).

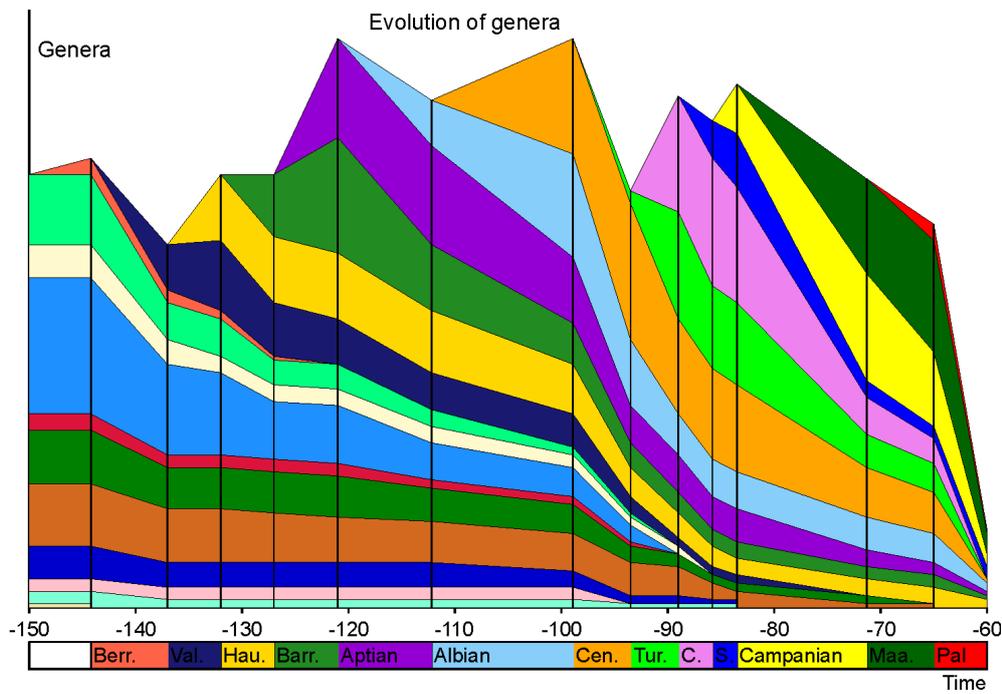


Figure 8. Example. As for instance, genera that were first detected during the Valanginian (deep blue) disappeared completely before the Campanian, whereas Hauterivian genera (gold) even passed the K/Pg boundary.

The time raster is very important for a proper result. If all age boundaries are used for this analysis, the results are not clear. Approximately 10 to 20 boundaries are recommended. The distance between the boundaries should be equal. If the examined time span is 100 ma, and you will choose 20 values, you should select the age boundaries each 5 ma.

## 007 Evolution of Species

Description : Numerical development of species which originated in a specified time interval. The graph shows the success of species originated in a certain time interval.

Displayed as : 007 Evolution of Species

Programme : PTXES007.PRF

Output chart : ES007.PGR

### Conditions

SPECIES table must have at least 100 records and AGE BOUNDARIES table must have at least 10 records. Species must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

### Options

(1) The first option allows the following:

1. Exclude endemic species (= species that occur only at one locality).
2. Exclude species in open nomenclature ('sp.' in the field *sname*).
3. Use the critical range data in the SPECIES table recorded by the user.

(2) The second option allows to restrict the analysis to a specific family or (current) genus.

(3) The third option requests which time raster should be used.

1. Records in AGE BOUNDARIES where "Show with text" is marked
2. Records in AGE BOUNDARIES where "Include in data estimation" is marked
3. Manual selection of records - The manual selection opens a table with the records from the AGE BOUNDARIES table. You can select and deselect records by pressing F8. Selected records are marked with an asterisk (\*) in the field of the record number. Finish with F10. The selection is kept in a file with the extension REC and the same records will be marked when the programme is executed again.
4. According to a numerical reference file - In this file you need to select a numerical reference file.

In the first three cases, a temporal numerical reference file (TEMP007.PSC) is created. The numerical reference file should cover the whole range of all the considered. So it is better to construct this file from the complete table of AGE BOUNDARIES. If the numerical reference does not have enough items, the programme will not be executed.

(3) The fourth option offers to limit the genera to a certain time span.

If a person is working with Mesozoic gastropods but wants to see only the evolution of the Jurassic species (species that reached the Jurassic or have their origin in the Jurassic) should limit the estimation to this time.

### Remarks

The image shows the success of species that occurred during a specific time span. It is the same estimation as 006 but it analyses species not genera. As above, the time raster is very important for a proper result. If all age boundaries are used for this analysis, the results are not clear. Approximately 10 to 20 boundaries are recommended. The distance between the boundaries should be equal. If the examined time span is 100 ma, and you will choose 20 values, you should select the age boundaries each 5 ma.

### ***008 Endemicity of Species***

Description : Numeric distribution of species, number of endemic species and rate of endemism

Displayed as : 008 Endemicity of species

Programme : PTXES008.PRF

Output values : ES008.DAT

Output chart : ES008.PRG

#### Conditions

SPECIES table must have at least 100 records and AGE BOUNDARIES table must have at least 10 records. Species must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

(1) The general option allows the following:

1. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table Species is 'sp.'. The absence of an author is not anymore considered as open taxonomy.
2. Use the critical data in the SPECIES table recorded by the user in place of the data calculated from the localities.
3. Comma instead of decimal point in output - Comma is used instead of point in the data output.

It is recommendable to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

- E1 Age data are invalid.
- E2 No data for output were found.

#### Remarks

The graph shows two polygons; the total number of species and the number of endemic species. A species is considered endemic when occurring at only one locality.

### ***010 Numerical distribution of genera and species compared***

Description : Numerical distribution of genera and species, number of species divided by the number of genera

Displayed as : 010 Numerical distribution/proportion of genera/species

Programme : PTXES010.PRF

Output values : ES010.DAT

Output chart : ES010.PRG

#### Conditions

SPECIES table must have at least 100 records and AGE BOUNDARIES table must have at least 10 records. Species must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

(1) The general option allows the following:

1. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table Species is 'sp.'. The absence of an author is not anymore considered as open taxonomy.
2. Use the critical data in the SPECIES table recorded by the user in place of the data calculated from the localities.
3. Use the critical data in the GENERA table recorded by the user in place of the data calculated from the species.
4. Calculate (species\*10)/genera in place of species/genera. This works better for genera with many species.
5. Comma instead of decimal point in output - Comma is used instead of point in the data output.

It is possible to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

No data for output were found.

#### Remarks

The graph shows three lines: the total number of genera and species and the number species divided of the number of genera.

### ***013 Numerical distribution of the first occurrence and life duration of species***

Description : Numerical distribution of the first occurrence of species and the life duration of the species

Displayed as : 013 Life duration of species through the time

Output values : ES013.DAT

Output chart : ES013.PGR

#### Conditions

SPECIES table must have at least 100 records and AGE BOUNDARIES table must have at least 10 records. Species must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

(1) The general option allows the following:

1. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table Species is 'sp.'. The absence of an author is not anymore considered as open taxonomy.
2. Use the critical data in the SPECIES table recorded by the user in place of the data calculated from the localities.
3. Define a lower limit of species to be shown. Normally, age boundaries are skipped in the output were no new species occur. The limiting value is zero. You may rise this value (5, 10) to skip also age boundaries, were less species (< 6, < 11) originated. This may give more clear results.
4. Comma instead of decimal point in output - Comma is used instead of point in the data output.

It is possible to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

No data for output were found.

#### Remarks

The graph shows two lines: the number of species that occur at a certain age boundary and the life time on average. The life time is summarised for all species occurring at the same boundaries, divided by 5 and divided by the number of species.

### ***015 Origination vs. extinction of genera***

Description : Numerical change of genus richness, based on analysis of originating and disappearing genera

Displayed as : 015 Origination vs. extinction rate in genera

Output values : ES015.DAT

Output chart : ES015.PGR

#### Conditions

GENERA table must have at least 20 records and AGE BOUNDARIES table must have at least 10 records. Species must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

(1) The general option allows the following:

1. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table SPECIES is 'sp.'. The absence of an author is not anymore considered as open taxonomy.
2. Suppress monospecific genera - excludes all genera from the analysis, to which only one species is assigned. If this option is set, the results are much clearer.
3. Use the critical data in the GENERA table recorded by the user in place of the data calculated from the species ranges.
4. Comma instead of decimal point in output - Comma is used instead of point in the data output.

It is possible to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

No data for output were found.

#### Remarks

The graph shows two lines: a green line for genera that had their origin at this point and a black line for genera that had their last occurrence at this point.

### ***016 Origination vs. extinction of species***

Description : Numerical change of genus richness, based on analysis of originating and disappearing species

Displayed as : 016 Origination vs. extinction rate in species

Output values : ES016.DAT

Output chart : ES016.PRF

#### Conditions

SPECIES table must have at least 50 records and AGE BOUNDARIES table must have at least 10 records. Species must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

The general option allows the following:

1. Exclude endemic species (= species that occur only at one locality).
2. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table SPECIES is 'sp.'. The absence of an author is not anymore considered as open taxonomy.
3. Use the critical data in the SPECIES table recorded by the user in place of the data calculated from the species ranges.
4. Comma instead of decimal point in output - Comma is used instead of point in the data output.

It is possible to select a numerical reference file.

#### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

No data for output were found.

### 021 Dating of localities

Description : Dating of localities based on the stratigraphy of the indicated species or genera

Displayed as : 021 Date faunas (by species or genera)

Output chart : ES021.PGR

#### Conditions

OCCURRENCE table must have at least 500 records. The SPECIES and GENERA tables must have at least 100 records. Table LOCALITIES must have records. Species and genera must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. A numerical reference file must be available, but can be also created automatically.

#### Options

The only option only asks for the data that should be used:

1. Calculated ranges of species.
2. Critical ranges of species.
3. Calculated ranges of genera.
4. Critical ranges of genera.

It is possible to select a numerical reference file.

The following errors can be reported:

E: No data for output were found.

#### Remarks

The idea behind this programme is described in detail in Löser (2002). It can be applied to obtain a probable age based on a larger set of range data.

First you are asked for the locality that should be analysed. You can only select one locality at one time. If you choose 'Calculated ranges...' and the selected locality has an age, it must be clear that this locality should be excluded from former setting of calculated species ranges. So, in this case mark the box 'Suppress locality' in the LOCALITY table, start the general estimation programme and exclude these localities by tagging 'Pay attention to field "Suppress locality" in Localities'.

Please note that the result shows absolute values. If the abundance of taxa varies much within the investigated time span, times with a high abundance result in a high score also for the questionable locality. In this case, the resulting scores must be divided by the global diversity (see for instance the example in Löser 2021).

The programme to show the graph consists of two parts. In the first part, data are summarised (Fig. 8). Here you should always confirm 'Adapt to the PCC Raster file'.

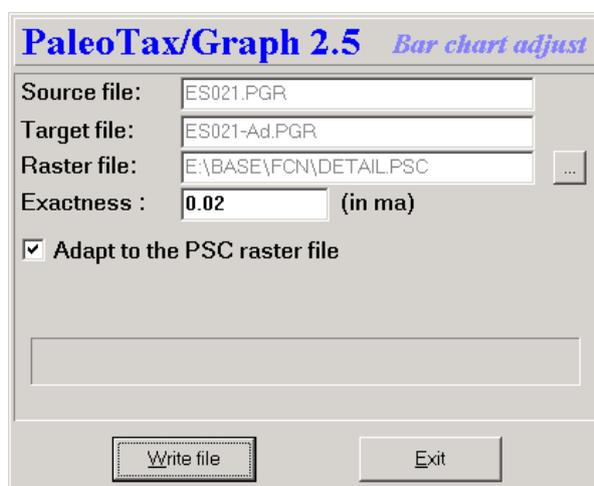


Figure 9. First step.

In a second step, the resulting graph is shown.

## 022 *Species richness vs. OAE/sea level*

Description	: Comparison of the number of species per age boundary to the number of anoxic events and the global sea level
Displayed as	: 022 Abundance of species and anoxic events/sea level
Output values	: ES022OAE.DAT / ES022SL.DAT
Output chart	: ES022OAE.PGR / ES022SL.PGR

### Conditions

SPECIES table must have at least 100 records and AGE BOUNDARIES table must have at least 10 records. Species must have calculated or critical ranges. Numerical values in the AGE BOUNDARIES table must be positive. There must be values for either the number of oceanic anoxic events or the sea level.

### Options

The general option allows the following:

1. Exclude endemic species (= species that occur only at one locality).
2. Suppress open determinations ('sp.') - Determinations in open taxonomy are suppressed. Open taxonomy is understood when the *species name* in the table SPECIES is 'sp.'. The absence of an author is not anymore considered as open taxonomy.
3. Use the critical data in the SPECIES table recorded by the user in place of the data calculated from the species ranges.
4. Comma instead of decimal point in output - Comma is used instead of point in the data output.

### Errors

The programme is not executed in the following cases:

1. A negative value in the field *value* in the table AGE BOUNDARIES. A zero value is only allowed as top.
2. When the top value is not lower than the bottom value in the table AGES.

The following errors can be reported:

- E1 Field *sealevel* in table AGE BOUNDARIES not found. - This field must be available in the AGE BOUNDARY table. It forms part of the standard.
- E2 Field *OAE* in table AGE BOUNDARIES not found. - This field must be available in the AGE BOUNDARY table. It forms part of the standard.
- E3 No data. - No range data of species available.
- E4 No OAE data. - If the number of oceanic anoxic events is not recorded in the AGE BOUNDARY table, a comparison is not possible.
- E5 No sea level data. - If the values of the global sea level are not recorded in the AGE BOUNDARY table, a comparison is not possible.

### ***024 Correlation of species based on localities***

Description : Correlation of species based on their occurrence  
Displayed as : 024 Correlation of species according to their occurrence  
Output chart : ES024.PGR

#### Conditions

SPECIES table must have at least 100 records, the locality table must have at least ten records and the OCCURRENCE table at least 50 records.

#### Options

The general option allows the following:

1. Pay attention to field "Suppress locality" in Localities - Localities that are suppressed are not included in the analysis.
2. Pay attention to field "Suppress citation" in citations - Suppressed citations are not included.
3. Suppress indications without description/illustration - Citations that are only listed and that have no description and/or illustration are not included.
4. Suppress open determinations (sp.) - Species having 'sp.' as species name, are suppressed.
5. Set limit for the age of localities (ma) - Very important option. It is possible to exclude localities with a very long range. A locality with the age 'Cretaceous' only blurs the results. It is a good method to put here the length of the longest stage within the stratigraphic framework of your area.
6. Suppress species with a low number of localities - Species that have a low number of localities, can be suppressed. The minimum number of localities is requested. Take into account that the calculation of the number of localities applies the options one to four of the same procedure.

The second option offer to limit the species to a certain time span. Species that do not occur in the selected time frame, are not included.

#### Errors

No data available.

#### Remarks

Correlation does only work for small data sets, something below 100 species and localities.

### ***029 Correlation of localities based on species***

Description : Correlation of localities based on species  
Displayed as : 029 Correlation of localities based on species  
Output chart : ES029.PGR

#### Conditions

SPECIES table must have at least 100 records, the locality table must have at least ten records and the OCCURRENCE table at least 50 records.

#### Options

The general option allows the following:

1. Pay attention to field "Suppress locality" in Localities - Localities that are suppressed are not included in the analysis.
2. Pay attention to field "Suppress citation" in citations - Suppressed citations are not included.
3. Suppress indications without description/illustration - Citations that are only listed and that have no description and/or illustration are not included.
4. Suppress open determinations (sp.) - Species having 'sp.' as species name, are suppressed.
5. Set limit for the age of localities (ma) - Very important option. It is possible to exclude localities with a very long range. A locality with the age 'Cretaceous' only blurs the results. It is a good method to put here the length of the longest stage within the stratigraphic framework of your area.
6. Suppress localities with a low number of species - Localities that have a low number of species, can be suppressed. The minimum number of species is requested. The value is compared to the value in the data field *lospec* in the Locality table.

The second option offer to limit the localities to a certain time span. Species that do not occur in the selected time frame, are not included.

#### Errors

No data available.

#### Remarks

Correlation does only work for small data sets, something below 100 species and localities. A limitation of the age of the localities helps much.

## Literature

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## Imprint

You are encouraged to propose estimation and data analysis programmes that would be interesting for you.

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Application Library PaleoTax

Data Estimation

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