

Chapter 2
 Life table analysis using TWOSEX-MSChart
 使用TWOSEX-MSChart分析生命表
 (基本方法 Basic method)

齊心教授
Prof. Dr. Hsin Chi
 Adjunct professor, National Chung Hsing University
 Adjunct professor, Fujian Agriculture and Forestry University
 Adjunct professor, Shandong Agricultural University

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Download new version of TWOSEX-MSChart
<http://140.120.197.173/Ecology/prod02.htm>

直接執行版 EXE version

There are two versions of each program. The "exe" version can be executed without setup. You may have to run them "As administrator". It is better to run these program from C: drive. 每個程式有兩個版本，"exe" 版本可以直接執行。建議使用管理員身分執行。(最好從C drive執行)

1. [TWOSEX-MSChart-exe-B100000.rar \(Version 2020.05.28\)](#)
2. [TIMING-MSChart-exe.rar \(Version 2020.03.31\)](#)
3. [CONSUME-MSChart-exe.rar \(Version 2020.03.31\)](#)
4. [Probit-MSChart-exe.rar \(Version 2020.05.21\)](#)
5. [LeafArea-exe.rar](#)

安裝版 Setup version

若無法使用 "exe" 版本，則必須使用下列版本安裝。最好安裝於C碟。
If you cannot run the "exe" version, you have to setup the following versions. They are now in English interface. It will be easier for you. It is better to setup the program in C: drive.

1. [TWOSEX-MSChart-B100000.rar \(Version 2020.05.28\)](#)
2. [TIMING-MSChart.rar \(Version 2020.03.31\)](#)
3. [CONSUME-MSChart.rar \(Version 2020.03.31\)](#)
4. [Probit-MSChart.rar \(Version 2020.05.21\)](#)
5. [LeafArea.rar](#)

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TWOSEX-MSChart can be used on Windows and Mac system

- TWOSEX has been used on Windows XP, 7, 8, 10. In most cases, there will be no problem.
- If you use Chinese or non-ASCII codes for the folder names, you may encounter some problems. But you can always find a solution for that. Only in extreme cases, you may have to re-install your operating system.
- On Mac computer, you have to use Windows operating system to run TWOSEX.

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Four ways to run TWOSEX

1. Extract TWOSEX-MSChart-exe-B100000.rar, run TWOSEX-MSChart.exe (or similar) as administrator.
2. Extract TWOSEX-MSChart-B100000.rar, run **setup.exe**. Then run TWOSEX as a Windows program.
3. Extract TWOSEX-MSChart-B100000.rar and put it on Desktop, run the program directly from the **Support folder**. (Run as administrator).
4. In rare cases, you have to install OCX (active control).

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1a. Open folder 0-Programs
Run TWOSEX-MSChart.exe

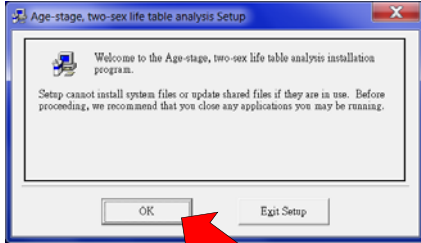
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1b. TWOSEX-MSChart-exe.rar

- A. If you download **TWOSEX-MSChart-exe.rar**, there is only one file TWOSEX-MSChart.exe, just click it to run. You don't need to setup the program.
- B. If you face problems, please click the right mouse key and try to run TWOSEX.exe "as administrator".**

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2. TWOSEX-MSChart-B100000.rar
Standard setup procedure
Double click on **setup.exe** and follow the **red arrow**



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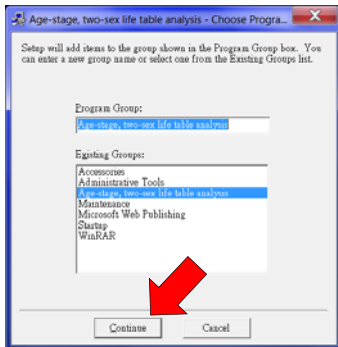
Click this button to install



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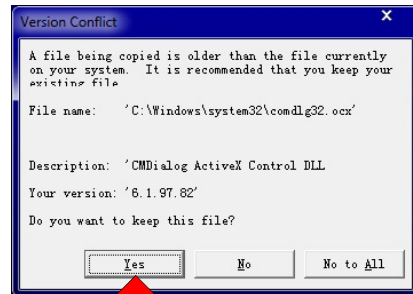
Just click on Continue



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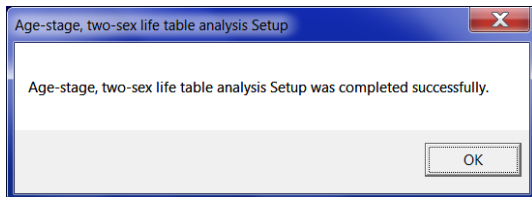
If you see this, just click Yes.



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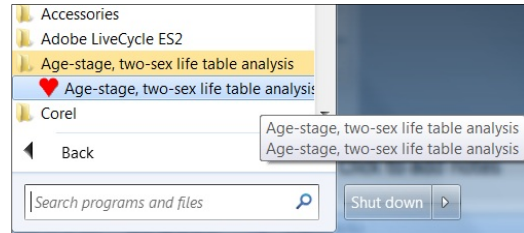
Setup was successfully



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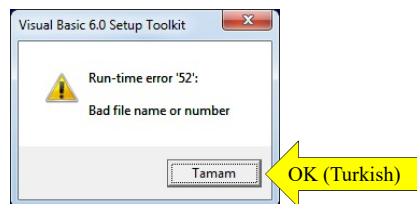
Now you can run TWOSEX



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3. Run TWOSEX-MSChart.exe from the Support folder.



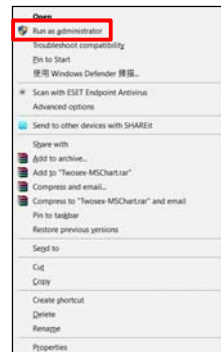
If you see this message, you can extract the RAR file and put it on the **Desktop**. Then you can run the program from the **Support** folder.

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If you cannot setup at all,

- If you are using Windows XP, you may face trouble and will not be able to setup the program.
- Extract TWOSEX-MSChart.rar to a new folder on your Desktop.
- Open the **Support** folder, find the file **TWOSEX-MSChart.exe**.
- Use right mouse key to click on it.
- Select "Run as administrator".



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4. Register OCX component to your computer (特殊狀況)



If you cannot run TWOSEX-MSChart.exe and you see this message (or similar), then you have to install the OCX file in order to run the program.

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How to register an OCX file

- You can find MSFLXGRD.OCX (and other OCX files) on the internet. Save them to C:\windows\system32 (or syswow64) folder.
- You need regsvr32.exe and regedit.exe (or regedt32.exe). If you cannot find them in your computer, you can download them from internet.
- Start the command mode: C:>
- Go to C:\Windows\system32 (or syswow64).
- Run C:>Regsvr32 MSFLXGRD.OCX. If it shows "successfully installed", you can continue.
- Run C:>Regedit vbctrls.reg or C:>regedt32 vbctrls.reg

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如何註冊OCX 檔案

- 如果安裝時軟件顯示缺少某個 OCX 檔案 (例如: MSFLXGRD.OCX). 可以在網路上找到, 將該檔案存於 C:\windows\system32 (或 syswow64) 檔案匣中.
- 安裝時必須使用 regsvr32.exe 與 regedit.exe (或 regedt32.exe). 若你的電腦上沒有這些檔案, 可以上網搜尋。
- 啟動指令模式 **C:>**
- 到 C:\Windows\system32 (or syswow64) 下.
- 執行 C:>Regsvr32 MSFLXGRD.OCX. 若顯示 "successfully installed", 可以繼續下一步.
- 執行 C:>Regedit vbctrls.reg 或 C:>regedt32 vbctrls.reg
- 可以使用其他方法註冊 OCX 檔案。

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If you use TWOSEX, you must cite the following references 所有使用 TWOSEX 者必須引用下面 3 文獻

- Chi, H., and H. Liu. 1985. Two new methods for the study of insect population ecology. Bull. Inst. Zool., Acad. Sin. 24: 225-240.
- Chi, H. 1988. Life-table analysis incorporating both sexes and variable development rates among individuals. Environ. Entomol. 17: 26-34.
- Chi, H. 2020. TWOSEX-MSChart: a computer program for the age-stage, two-sex life table analysis. National Chung Hsing University, Taichung, Taiwan, (<http://140.120.197.173/Ecology/Download/Twosex-MSChart.zip>) (accessed 1 August 2020). (Replace 2020 with the actual year you downloaded the program) (寫明你使用的版本年份).

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Formal

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If you use TWSEX-MSChart program, you have to cite following reference:
1. Chi, H. and H. Y. Su. 2006. Age-stage, two-sex life tables of *Aphis gossypii* (Homoptera: Pemphigidae) and how to use the program. Entomol. Entomol. 17: 24-34.
2. Chi, H. and H. Liu. 2005. Two new methods for the study of insect population ecology. Bull. Inst. Zool., Academia Sinica 24: 227-240.
3. Chi, H. 2018. TWSEX-MSChart: a computer program for the age-stage, two-sex life table analysis. <http://140.120.197.173/Ecology>. (Please cite the Year in the TWSEX program.)
If you report the age-stage life expectancy (ex) or age-specific (ex) life expectancy you obtained from the TWSEX program, you have to cite following reference:
1. Chang, C.H., Chang, C.H. and Hsin Chi, 2016. Population and damage prediction of *Spodoptera litura* (L.) on peanuts (*Arachis hypogaea* L.) under different conditions using the age-stage, two-sex life table. *Journal of Economic Entomology* 109(1): 97-99.
If you report the age-stage reproductive value (rv) or age-specific (rv) reproductive value you obtained from the TWSEX program, you have to cite following reference:
1. Tsun, Shu-Wei, Chang-Chieh Lee and Hsin Chi, 2016. Population and damage prediction of *Spodoptera litura* (L.) on peanuts (*Arachis hypogaea* L.) under different conditions using the age-stage, two-sex life table. *PeerJ Manag. Sci.* 70: 887-813.
2. Tsun, Shu-Wei, Chang-Chieh Lee and Hsin Chi, 2016. Population and damage prediction of *Spodoptera litura* (L.) on peanuts (*Arachis hypogaea* L.) under different conditions using the age-stage, two-sex life table. *PeerJ Manag. Sci.* 70: 1816.
If you report the 0.12d and 0.75 fecundity life tables you obtained from the TWSEX program, you have to cite following reference:
1. Huang, H. W., H. Chi, and C. L. Su. 2018. Linking demography and consumption of *Empoasca vitipes* (Coleoptera: Cicadellidae) fed on *Solanum phaeocephalum* with a new method to project the uncertainty of population growth and consumption. *Journal of Economic Entomology* 111(1): 1-9. doi: 10.1093/jee/tax130
If you collect over life table analysis, you have to cite following reference:
1. Zhang, Xiao-Min, Hsin Chi, Dong Chi, 2016. A simplified recording method for insect life table studies: a case study based on *Bemisia tabaci* (Homoptera: Aleyrodidae). *Acta Entomologica Sinica* 59(3): 663-668.
If you use the 1-D life table, you have to cite following reference:
1. Huang, Y. B. and Hsin Chi, 2011. The age-stage, two-sex life table with an offspring sex ratio dependent on female age. *Journal of Agriculture and Forestry* 65(4): 317-345.

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Step 1: Enter your username. Then press Enter or click on "Check username" if you are registered user, you can enter your password to run this program. If you are unregistered user, you have to read the License Agreement. After you read the License Agreement and check the button "I have read and accept authorization, if they agree to follow the general academic ethics. If you don't want to follow the academic ethics, you should not use this program. You must understand that you are using my theory AND my program. Therefore, you must cite Chi and Liu (1985), Chi (1988), and this program in your paper, lecture materials, and any other forms of publication. Honest citation is the basic academic ethics and it protects you from accusation of plagiarism. If you don't agree with any of these conditions and the license agreement enclosed with this program, you should not use this program and should delete this program from your computer and other storage devices. If you need help, please write to: hsinchi@dragon.nchu.edu.tw or chi6604@gmail.com. If you don't receive response from me, then you can contact qqq@bbs@gmail.com.

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Password: 4: Enter your password: 5: Run

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If the password is correct, you can see the main page.
若密碼正確，您可以看到主頁。

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You have to collect 1. Stage developmental duration of each individual. 2. sex of each individual. 3. Daily fecundity of all females.

No.	Sex	Developmental duration				Daily fecundity												
		Egg	Larva	Pupa	Adult	1	2	3	4	5	6	7	8	9				
1	M	6	11	12	6													
2	F	6	10	11	10	0	124	12	0	4	2							
3	F	6	11	10	10	0	22	74	13	0	1							
4	F	6	12	10	7	0	97	28	1	4	0							
5	M	6	12	11	5													
6	F	6	12	11	14	0	61	11	7	15	15	2	3	4				
7	M	6	13	10	8													
..													
16	F	6	13	11	9	100	17	45	8									
..													
19	N	6	13	-8														
20	N	6	-10															

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Write data for individuals no. 1 and 2

1,M,6,11,12,6
2,F,6,10,11,10,0,124,12,0,4,2,0,0,0,-1

or

1,M,6,11,12,6
2,F,6,10,11,10,0,124,12,0,4,2,-1

or

1,M,6,11,12,6
2,F,6,10,11,10
0,124,12,0,4,2,-1

Ending zeros are omitted. 省略尾端的0.

Developmental time and fecundity in separate lines. 繁殖率另寫一行。

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Detailed explanation of data format

"Project: Diamondback moth at 25C"

"User: Ta-Chi Yang"

"DBM."

50 (Number of eggs used at the beginning)

3,7 (Number of types, number of stages)

F, Egg, L1,L2,L3,L4,Pupa,Female (Female stages)

M, Egg, L1,L2,L3,L4,Pupa,Male (Male stages)

N, Egg, L1,L2,L3,L4,Pupa,Unknown (Unknown type)

L1,L4 (Special grouping: total time from L1 to L4)

1,M,7,3,4,5,6,5,8 (Developmental time)

2,F,7,2,3,4,5,8,6,4,12,9,5,8,0,-1 (Daily fecundity)

3,N,7,-7 (Died on 7th day of L1)

4,F,6,2,3,4,5,7,19,0,0,2,20,9,6,5,10,8,13,10,12,9,0,0,-1

Don't use "°C" or any non-ASCII code. 勿用中文。

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Data format for 7 developmental stages

"Project: Silverleaf whitefly at 25C"

"User: Hsin Chi"

"25C" → Treatment code. As short as possible!

50

3,7

F, Egg, L1,L2,L3,L4,Pupa,Female

M, Egg, L1,L2,L3,L4,Pupa,Male

N, Egg, L1,L2,L3,L4,Pupa,Unknown

L1,L4

1,M,7,3,4,5,6,5,8

2,F,7,2,3,4,5,8

3,N,7,-7 → Individuals died in immature stages are N type!

4,F,.....

Descriptive data and definition

Developmental time for each individual and fecundity for each female

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Data format for 7 developmental stages

"Project: Silverleaf whitefly at 25C"

"User: Hsin Chi"

"25C" → Don't use "°C".

50

3,7

F, Egg, L1,L2,L3,L4,Pupa,Female

M, Egg, L1,L2,L3,L4,Pupa,Male

N, Egg, L1,L4 → This line asks the program to calculate the total larval duration.

1,M,7,3,4,5,8

2,F,7,2,3,4,5,8,6,4,12,9,5,8,0,-1

3,N,7,-7

4,F,.....

Descriptive data and definition

Developmental time for each individual and fecundity for each female

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Data format for 2 developmental stages

```

"Project: Silverleaf whitefly at 30C"
"User: Hsin Chi"
"30C"
50
3,2
F, Immature, Female
M, Immature, Male
N, Immature, Unknown
Immature, Female
1,M,30,8
2,F,29,6,4,12
3,N,-7
4,F,.....
    
```

Descriptive data and definition

Developmental time for each individual and fecundity for each female

Treatment code. As short as possible!

You must have this line.

Individuals died in immature stages are N type!

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Data format for Parthenogenetic populations
孤雌生殖種群資料格式

```

"Aphis gossypii"
"Shally"
"25C"
56
2,5
F,N1,N2,N3,N4,Female
N,N1,N2,N3,N4,Unknown
N1,N4
1,F,2,1,3,1,18,0,9,0,11,12, ..., -1
.....
48,N,1,3,-1
.....
    
```

Descriptive data and definition

Developmental time for each individual and fecundity for each female

Treatment code. As short as possible!

Individuals died in immature stages are N type!

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Data format for Parthenogenetic populations
孤雌生殖種群資料格式 (三種型: F, M, N)

```

"Aphis gossypii"
"Shally"
"25C"
56
3,5
F,N1,N2,N3,N4,Female
M,N1,N2,N3,N4,Male
N,N1,N2,N3,N4,Unknown
N1,N4
1,F,2,1,3,1,18,0,9,0,11,12, ..., -1
.....
48,N,1,3,-1
.....
    
```

Descriptive data and definition

Developmental time for each individual and fecundity for each female

It is OK to write this line. 沒有雄蟲仍可以寫這一行

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Data format for 7 developmental stages with stage-specific rearing cost (含飼養費用之資料)

```

"Project: Diamondback moth at 25C"
"User: Hsin Chi"
"DBM."
50
3,7
F, Egg, L1,L2,L3,L4,Pupa,Female
M, Egg, L1,L2,L3,L4,Pupa,Male
N, Egg, L1,L2,L3,L4,Pupa,Unknown
0, 0.2, 0.3, 0.5, 1, 0, 2, 1.5
L1,L4
    
```

The rearing cost for egg, L1, L2, L3, L4, Pupa, Female and Male adults are 0, 0.2, 0.3, 0.5, 1, 0, 2, and 1.5, respectively.

Not well! There are 8 data. 2 is the rearing cost of female and 1.5 is the cost of male.

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資料格式：7 發育階段與飼養費用

```

"Project: Diamondback moth at 25C"
"User: Hsin Chi"
"DBM."
50
3,7
F, Egg, L1,L2,L3,L4,Pupa,Female
M, Egg, L1,L2,L3,L4,Pupa,Male
N, Egg, L1,L2,L3,L4,Pupa,Unknown
0, 0.2, 0.3, 0.5, 1, 0, 2, 1.5
L1,L4
    
```

The rearing cost for egg, L1, L2, L3, L4, Pupa, Female and Male adults are 0, 0.2, 0.3, 0.5, 1, 0, 2, and 1.5, respectively.

注意：有8個飼養費用。最後兩個是雌雄成蟲的飼養費用。

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Attention!

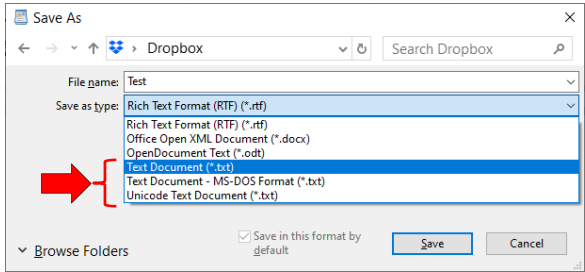
Do NOT enter more than 30 data items in each line. Press ENTER at the end of each line.

建議：每行不要超過30個資料

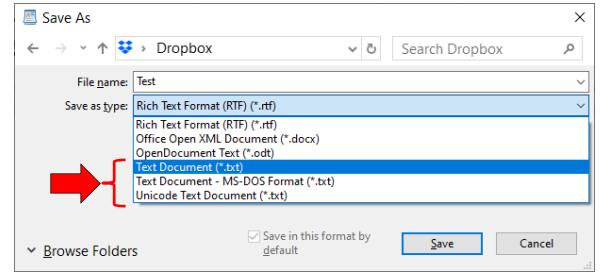
理由：容易閱讀與偵錯

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請用 **WordPad, Notepad** 寫生命表資料，存入檔案匣 Life table example\1-Example 1d.txt.
 如果使用 NotePad 產生錯誤，建議使用 WordPad.

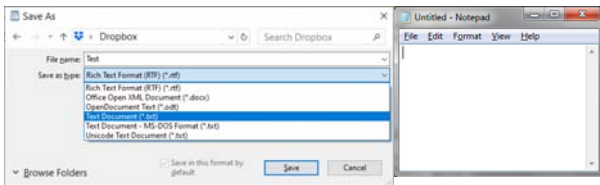


Prepare a data file for TWSEX-MSChart in folder "Life table example\1-Example 1d".
 Use pure text editors: **WordPad, Notepad.**



Prepare a data file for TWSEX-MSChart in folder "Life table example\1-Example 1d".
 請用 **WordPad, Notepad** 寫生命表資料.

Note! Use only a pure text editor (e.g., **WordPad, Notepad**) to write your data file (i.e., txt file). If you face problem with Notepad, you can try WordPad.



Use “.” as decimal symbol
 Don't use “,” as decimal symbol

Control panel → Clock, Language, and Region → Region and language → Change keyboards or other input method → Formats → Format: English → Additional settings → Decimal symbol → “.”

Exercise 1: Prepare your data file (20 individuals)
 練習一：準備生命表資料檔案 (20隻)

No.	Sex	Developmental duration				Daily fecundity													
		Egg	Larva	Pupa	Adult	1	2	3	4	5	6	7	8	9					
1	M	6	11	12	6														
2	F	6	10	11	10	0	124	12	0	4	2								
3	F	6	11	10	10	0	22	74	13	0	1								
4	F	6	12	10	7	0	97	28	1	4	0								
5	M	6	12	11	5														
6	F	6	12	11	14	0	61	11	7	15	15	2	3	4					
7	M	6	13	10	8														
..														
16	F	6	13	11	9	100	17	45	8										
..														
19	N	6	13	-8															
20	N	6	-10																

Please use Notepad to write a life table data file and save in the folder "Life table examples\1-Life table example".

```

"Example of life table raw data"
"Chi, H."
"25C"
20
3,4
F,Egg,Larva,Pupa,Female
M,Egg,Larva,Pupa,Male
N,Egg,Larva,Pupa,Unknown
Larva, Pupa
1,M,6,11,12,6
2,F,6,10,11,10,0,124,12,0,4,2,-1
3,F,6,11,10,10,0,22,74,13,0,1,-1
4,F,6,12,10,7,0,97,28,1,4,0,-1
5,M,6,12,11,5
6,F,6,13,12,10,44,53,11,15,2,-1
7,M,6,13,10,10,2,90,5,12,-1
8,M,6,14,10,6
9,F,6,13,12,10,44,53,11,15,2,-1
10,M,6,13,11,8
11,F,6,13,12,10,44,53,11,15,2,-1
12,F,6,12,12,8,75,48,12,4,1,-1
13,F,6,13,10,10,2,90,5,12,-1
14,M,6,13,11,8
15,F,6,13,12,10,44,53,11,15,2,-1
16,F,6,13,11,9,100,17,45,8,-1
17,M,6,14,10,6
18,F,6,14,11,6,9,111,27,4,-1
19,N,6,13,-8
20,N,6,-10
    
```

Please add the rearing cost to your data file and save in the folder "Life table examples 5-life table with rearing cost".

"Example of life table raw data"
 "Chi, H."
 "25C"
 20
 3,4
 F,Egg,Larva,Pupa,Female
 M,Egg,Larva,Pupa,Male
 N,Egg,Larva,Pupa,Unknown
 0,1,0,2,1 ← 飼養費用 Rearing cost
 Larva, Pupa
 1,M,6,11,12,6
 2,F,6,10,11,10,0,124,12,0,4,2,-1
 3,F,6,11,10,10,0,22,74,13,0,1,-1
 4,F,6,12,10,7,0,97,28,1,4,0,-1
 5,M,6,12,11,5
 6,F,6,12,11,14,0,61,11,7,15,15,2,3,4,-1

7,M,6,13,10,8
 8,F,6,11,9,11,0,0,26,36,9,6,2,-1
 9,F,6,12,11,9,67,37,10,5,1,-1
 10,M,6,12,11,6
 11,M,6,12,12,7
 12,F,6,12,12,8,75,48,12,4,1,-1
 13,F,6,13,10,10,2,90,5,12,-1
 14,M,6,13,11,8
 15,F,6,13,12,10,44,53,11,15,2,-1
 16,F,6,13,11,9,100,17,45,8,-1
 17,M,6,14,10,6
 18,F,6,14,11,6,9,111,27,4,-1
 19,N,6,13,-8
 20,N,6,-10

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A1. Open data file

A1. 開啟資料檔案

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Open data file 開啟資料檔

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Life table only? 一般生命表?

Rearing cost for each stage?

Regular life table?
 Yes: Life table data only.
 No: Life table data with rearing cost.
 If there is no rearing cost, you must select "Yes".

Yes No

If it is a regular life table without rearing cost, you have to select "Yes".
 如果是一般生命表沒有飼養費用，請選Yes.

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Is two-sex mating necessary?

Gute Nacht!

Two-sex mating?

Is two-sex mating necessary for a successful reproduction?
 If parthenogenetic reproduction is possible, you can choose "No".
 If there are only females in your data file, you MUST choose "No".

Yes No

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Error message 錯誤訊息

Error in data file

Check data of individual no. 1 or 2
 Please correct your data and rerun this program.
 (If you need help, please contact hsinchi@dragon.nchu.edu.tw)

檢查第一隻或第二隻之資料，
 更正後再重新運行。

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Basic analysis

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A2. Basic Run 基本分析

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Fecundity coefficient = 1 (繁殖率係數 = 1)

In most cases, you click on OK.
If you enter 0.5, you can see the effect of 0.5 fecundity on the population parameters.

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Default: Time unit = 1 day 生命表紀錄時間單位 (預設值 1 天)

You should enter the value for the time unit you used in life table study.

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Time unit: 1, 0.5, 0.3, 0.25, 0.2, 0.16...

- To make it easier to run the program, I let you enter 0.3 for 8-h data and 0.16 for 4-h data.
- Because 8 h is truly 1/3 d, not 0.3 d, the true value 1/3 and 1/6 is used in the calculation in the TWSEX program. Because most people use 1 d or 0.5 d, you may not notice that special care has been taken into consideration. **This is important in scientific calculation.**

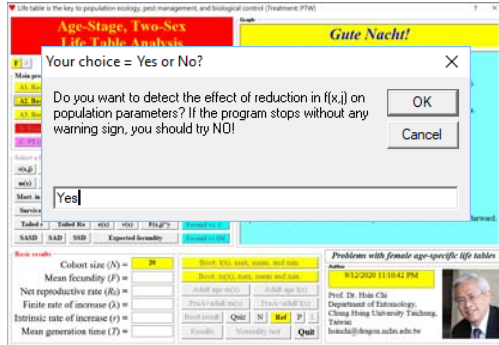
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More options? (Mostly NO. 一般選擇 NO)

1. If you want to see more options, choose Yes.
2. In case you face problem, you should try Yes.
3. If you want to run 3D life table, pick Yes.

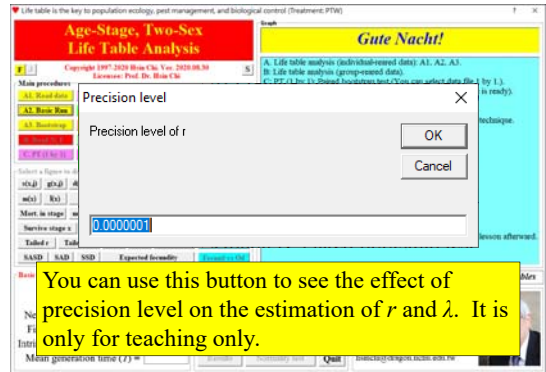
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If there is no error in your data file, but you still cannot run the program, you have to try NO here.
 若資料檔沒有錯誤，卻仍無法分析，此處須改“No”。



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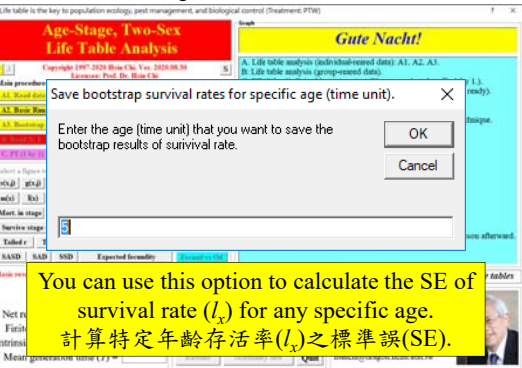
Precision level of r
 (In general, just click on OK)



You can use this button to see the effect of precision level on the estimation of r and λ . It is only for teaching only.

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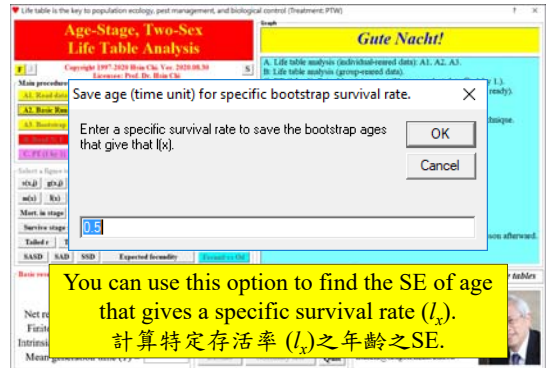
Save bootstrap survival rates of specific age
 保存bootstrap 樣本之特定年齡存活率



You can use this option to calculate the SE of survival rate (l_x) for any specific age.
 計算特定年齡存活率(l_x)之標準誤(SE).

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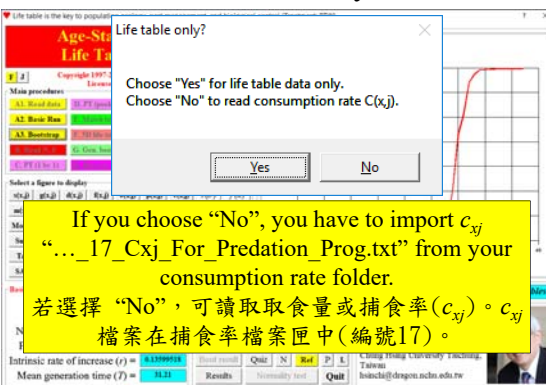
Find the age for a specific survival rate
 尋找特定存活率之年齡



You can use this option to find the SE of age that gives a specific survival rate (l_x).
 計算特定存活率(l_x)之年齡之SE.

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Life table only?



If you choose “No”, you have to import c_{xj} “..._17_Cxj_For_Predation_Prog.txt” from your consumption rate folder.
 若選擇 “No”，可讀取取食量或捕食率(c_{xj})。 c_{xj} 檔案在捕食率檔案匣中(編號17)。

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Quiz (測驗)



你能計算種群中的雌蟲數嗎?

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$$R_0 = \frac{N_f}{N} \times F$$

$$R_0 = 69.7$$

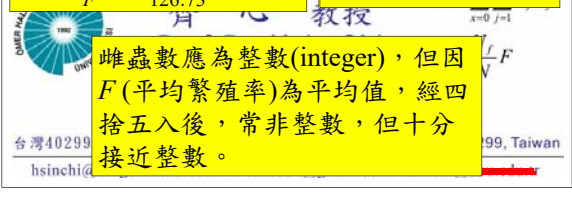
$$N = 20$$

$$F = 126.7273$$

$$N_f = \frac{R_0 \times N}{F} = \frac{69.7 \times 20}{126.73} = 10.9997$$

N_f must be an integer. However, because F is a mean value (it is not an integer) and due to the rounding-off, we get 10.9997. But we know it must be 11.

雌蟲數應為整數(integer)，但因 F (平均繁殖率) 為平均值，經四捨五入後，常非整數，但十分接近整數。



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Definition of parameters 種群參數定義

The net reproductive rate (R_0) is the mean number of offspring produced by an individual during its lifetime and can be calculated by using following equations:

$$R_0 = \sum_{x=0}^k s_{xj} f_{xj}, \quad R_0 = \sum_{x=0}^k l_x m_x, \quad \text{or} \quad R_0 = \frac{N_f}{N} F$$

where k is the number of stage. It is not based on the assumption of stable age-stage distribution, stable age distribution or stable stage distribution. 淨增殖率是種群中每個個體一生中產生的子代數。計算淨增殖率不須假設種群達到穩定年齡期分布。

Colony size (N) = 20

Mean fecundity (F) = 126.7273

Net reproductive rate (R0) = 69.7

Finite rate of increase (lambda) = 1.1496937

Intrinsic rate of increase (r) = 0.13599528

Mean generation time (T) = 51.31

Problems with female age-specific life tables

W12/2020 11:03:43 PM

Prof. Dr. Hsin Chi
Department of Entomology,
Chung Hsing University Taichung,
Taiwan
hsinchi@dragon.nchu.edu.tw

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Population parameters (種群介量)

Mean fecundity: $F = \frac{\sum_{x=1}^{N_f} E_x}{N_f}$
平均繁殖率

Net reproductive rate: $R_0 = \sum_{x=0}^{\infty} \sum_{j=1}^m s_{xj} f_{xj} = \sum_{x=0}^{\infty} l_x m_x$ $R_0 = \sum_{x=0}^{\infty} l_x m_x$
淨增殖率

Intrinsic rate of increase (r): $\sum_{x=0}^{\infty} \left(e^{-r(x+1)} \sum_{j=1}^m s_{xj} f_{xj} \right) = 1$ $\sum_{x=0}^{\infty} e^{-r(x+1)} l_x m_x = 1$
內稟增長率

Finite rate of increase: $\lambda = e^r$
周限增長率

Mean generation time: $T = \frac{\ln R_0}{r}$
平均世代時間

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Net reproductive rate 淨增殖率

The **total mean** number of offspring that **an average individual** (including females, males, and those died in immature stage) can produce **during its lifetime**. The magnification that a population will increase after one generation. 一個平均個體(包含雌蟲、雄蟲、以及在成蟲前期死亡者)一生中所產生的子代總數(包含雌蟲、雄蟲、以及在成蟲前期死亡者)。

$$R_0 = \sum_{x=0}^{\infty} \sum_{j=1}^m s_{xj} f_{xj} \quad l_x = \sum_{j=1}^m s_{xj} \quad m_x = \frac{\sum_{j=1}^m s_{xj} f_{xj}}{\sum_{j=1}^m s_{xj}} = \frac{\sum_{j=1}^m s_{xj} f_{xj}}{l_x}$$

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Chi (1988) proved 淨增殖率與繁殖率之關係

$$R_0 = \frac{N_f}{N} F$$

where N_f is the number of female adults emerged from the total individuals N used at the beginning of life table study and F is the mean fecundity of this N_f females. **This relationship is valid for the age-stage, two-sex life table and female age-specific life table.** For two-sex life table: $N - N_f = N_d + N_m$ (number of dead in preadult stage + number of male adults). For female life table: $N - N_f = N_d$ (number of dead in preadult).

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Intrinsic rate of increase 內稟增長率

It is the population growth rate as time approaches infinity and population reaches the stable age-stage distribution. The population size will increase at the rate of e^r per time unit.

$$\sum_{x=0}^{\infty} \left(e^{-r(x+1)} \sum_{j=1}^m f_{xj} s_{xj} \right) = 1$$

TWSEX life table uses this one.

$$\sum_{x=1}^{\infty} \left(e^{-rx} \sum_{j=1}^m f_{xj} s_{xj} \right) = 1$$

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Intrinsic rate of increase (time unit 0.5)

It is the population growth rate as time approaches infinity and population reaches the stable age-stage distribution. The population size will increase at the rate of e^r per time unit.

$$\sum_{x=0}^{\infty} \left(e^{-r[(x+1) \times 0.5]} \sum_{j=1}^m f_{xj} s_{xj} \right) = 1$$

where $x = 0, 1, 2, \dots$

TWSEX life table uses this one.

All r and λ are irrational numbers, except for $r = 0$ and $\lambda = 1$.

In general, e^q is irrational for any non-zero rational q .

$\lambda = e^r$. For any non-zero r , λ is irrational, thus, its corresponding r is irrational.

Reference:

Aigner, Martin; Ziegler, Günter M. (1998), Proofs from THE BOOK (4th ed.), Berlin, New York: Springer-Verlag, pp. 27–36, doi:10.1007/978-3-642-00856-6, ISBN 978-3-642-00855-9.

Finite rate of increase 周限增長率

The finite rate is the population growth rate as time approaches infinity and population reaches the stable age-stage distribution. The population size will increase at the rate of λ per time unit.

$$\sum_{x=0}^{\infty} \left(\lambda^{-(x+1)} \sum_{j=1}^m f_{xj} s_{xj} \right) = 1 \rightarrow \text{TWSEX life table uses this one.}$$

$$\sum_{x=1}^{\infty} \left(\lambda^{-x} \sum_{j=1}^m f_{xj} s_{xj} \right) = 1$$

Mean generation time 平均世代時間

It is the period that a population requires to increase to R_0 -fold of its size as time approaches infinity and the population settles down to a stable age-stage distribution (SASD), i.e., stable age distribution SAD, too. **A shorter generation time doesn't mean faster growth rate.**

$$\lambda^T = R_0$$

$$T = \ln R_0 / \ln \lambda$$

$$\lambda = e^r$$

$$\lambda^T = e^{rT} = R_0$$

$$T = \frac{\ln R_0}{r}$$

Mean generation time (T)

The mean generation time (T) is defined as the length of time that a population needs to increase to R_0 -fold of its size (i.e., $e^{rT} = R_0$ or $\lambda^T = R_0$) at the stable age distribution (SAD).

Lotka (1913)

For the stable age-distribution this becomes by (1)

$$b_m = b_m \int_0^{\infty} e^{-ra} p_m(a) \beta_m(a) da \quad (27)$$

$$1 = \int_0^{\infty} e^{-ra} p_m(a) \beta_m(a) da \quad (28)$$

an equation which determines r .

Equation (28) gives rise to two reflections.

In the first place it can be seen by inspection, that $r \geq 0$ according as $\int_0^{\infty} p_m(a) \beta_m(a) da \geq 1$. This is due to the fact that this last integral represents the ratio of the total male births in two successive generations.

Lotka, A. J. 1913. A natural population norm. II. Journal of the Washington Academy of Sciences. Vol. 3, No. 9 (MAY 4, 1913), pp. 289-293.

Lewis (1942)

“A net reproduction rate $> \leq 1$ means $\lambda > \leq 1$, and vice versa, but the magnitudes of the two measures will be different.”

$$R_0 > 1, \lambda > 1$$

$$R_0 = 1, \lambda = 1$$

$$R_0 < 1, \lambda < 1$$

Lewis, E. G. 1942. On the generation and growth of a population. Sankhya 6: 93-96.

Important and basic relationship

$$R_0 > 1, r > 0, \lambda > 1.$$

$$R_0 = 1, r = 0, \lambda = 1.$$

$$R_0 < 1, r < 0, \lambda < 1.$$

How many digits should you report?

$$\lambda = e^r$$

$$\lambda = 1 \Leftrightarrow r = 0$$

$$r = 0.1460, \lambda = 1.1572$$

4 decimal points

Please report at least 3 or 4 decimal points.

Quiz 小測驗

Answer 答案

Quiz 小測驗

Quiz 小測驗

Age-Stage, Two-Sex Life Table Analysis

Survival rate to each age-stage group
It is the probability that a newborn will survive to age x and stage j.

Total eggs?

What is the total number of eggs laid by this cohort?

Your answer =

你會計算種群的總產卵數嗎?

Basic results:

Cohort size (N) = 20	Adult age (x0)	Adult age (x1)
Mean fecundity (F) = 116.779	PreA+adult (m0)	PreA+adult (m1)
Net reproductive rate (R0) = 69.7	Adult age (x0)	Adult age (x1)
Finite rate of increase (lambda) = 1.1495937	PreA+adult (m0)	PreA+adult (m1)
Intrinsic rate of increase (r) = 0.1399918	Adult age (x0)	Adult age (x1)
Mean generation time (T) = 31.31	PreA+adult (m0)	PreA+adult (m1)

Prof. Dr. Hsin Chi
Department of Entomology,
Chang Hsing University Taichung,
Taiwan
hsinchi@dragon.nchu.edu.tw

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Quiz

Age-Stage, Two-Sex Life Table Analysis

Survival rate to each age-stage group
It is the probability that a newborn will survive to age x and stage j.

Total eggs?

What is the total number of eggs laid by this cohort?

Your answer =

Total eggs = $N_f \times F = R_0 \times N$

Basic results:

Cohort size (N) = 20	Adult age (x0)	Adult age (x1)
Mean fecundity (F) = 116.779	PreA+adult (m0)	PreA+adult (m1)
Net reproductive rate (R0) = 69.7	Adult age (x0)	Adult age (x1)
Finite rate of increase (lambda) = 1.1495937	PreA+adult (m0)	PreA+adult (m1)
Intrinsic rate of increase (r) = 0.1399918	Adult age (x0)	Adult age (x1)
Mean generation time (T) = 31.31	PreA+adult (m0)	PreA+adult (m1)

Prof. Dr. Hsin Chi
Department of Entomology,
Chang Hsing University Taichung,
Taiwan
hsinchi@dragon.nchu.edu.tw

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Answer 答案

Age-Stage, Two-Sex Life Table Analysis

What is the total number of eggs laid by this cohort?

Your answer =

Wrong!

The correct answer is =

"Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed." – A. Einstein

The total number of eggs laid by a cohort can be calculated from following equation:

$$E_{total} = R_0 \times N = F \times N_f = F_r \times N_{f_r}$$

Basic results:

Cohort size (N) = 20	Adult age (x0)	Adult age (x1)
Mean fecundity (F) = 116.779	PreA+adult (m0)	PreA+adult (m1)
Net reproductive rate (R0) = 69.7	Adult age (x0)	Adult age (x1)
Finite rate of increase (lambda) = 1.1495937	PreA+adult (m0)	PreA+adult (m1)
Intrinsic rate of increase (r) = 0.1399918	Adult age (x0)	Adult age (x1)
Mean generation time (T) = 31.31	PreA+adult (m0)	PreA+adult (m1)

Prof. Dr. Hsin Chi
Department of Entomology,
Chang Hsing University Taichung,
Taiwan
hsinchi@dragon.nchu.edu.tw

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Answer 答案

Disposition period and days

Can you calculate the number of eggs per oviposition day?

Number of reproductive females = Oviposition days =

Eggs per oviposition day (Your answer) =

Wrong!

The correct answer of oviposition days is =

"Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed." – A. Einstein

The eggs per oviposition day (E_d) can be calculated from following equations:

$$R_0 = E_d \times O_d \times \frac{N_f}{N} \quad E_d = \frac{R_0 \times N}{N_f \times O_d}$$

Basic results:

Cohort size (N) = 20	Adult age (x0)	Adult age (x1)
Mean fecundity (F) = 116.779	PreA+adult (m0)	PreA+adult (m1)
Net reproductive rate (R0) = 69.7	Adult age (x0)	Adult age (x1)
Finite rate of increase (lambda) = 1.1495937	PreA+adult (m0)	PreA+adult (m1)
Intrinsic rate of increase (r) = 0.1399918	Adult age (x0)	Adult age (x1)
Mean generation time (T) = 31.31	PreA+adult (m0)	PreA+adult (m1)

Prof. Dr. Hsin Chi
Department of Entomology,
Chang Hsing University Taichung,
Taiwan
hsinchi@dragon.nchu.edu.tw

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Basic Run completed 基本分析完成

Age-Stage, Two-Sex Life Table Analysis

Survival rate to each age-stage group
It is the probability that a newborn will survive to age x and stage j.

Main procedures:

- 1. Input data
- 2. Calculation
- 3. Output

Select a figure to display:

Survival rate (s(x,j)) vs Age (x)

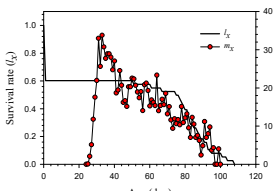
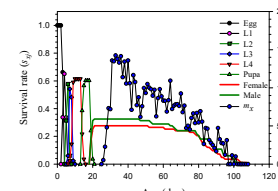
Basic results:

Cohort size (N) = 20	Adult age (x0)	Adult age (x1)
Mean fecundity (F) = 116.779	PreA+adult (m0)	PreA+adult (m1)
Net reproductive rate (R0) = 69.7	Adult age (x0)	Adult age (x1)
Finite rate of increase (lambda) = 1.1495937	PreA+adult (m0)	PreA+adult (m1)
Intrinsic rate of increase (r) = 0.1399918	Adult age (x0)	Adult age (x1)
Mean generation time (T) = 31.31	PreA+adult (m0)	PreA+adult (m1)

Prof. Dr. Hsin Chi
Department of Entomology,
Chang Hsing University Taichung,
Taiwan
hsinchi@dragon.nchu.edu.tw

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"Whether you can observe a thing or not depends on the theory which you use. It is the theory which decides what can be observed." – A. Einstein

If you use a female age-specific life table, you will never see the stage differentiation and male population.

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Life table is real big data
生命表是有系統的大數據

Life table data

- Survival rate
- Developmental rate
- Fecundity
- Sex ratio
- Stage differentiation
- Viable eggs
- Age-specific hatch rate
-

Life table analysis must be based on theories

Life table theory:

- Net reproductive rate
- Intrinsic rate
- Life expectancy
- Reproductive value
- Population projection
-

Statistical theory:

- Bootstrap sampling
- Central limit theory
-

They are all closely related.

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Truth exists independent of awareness, but scientists bring it to awareness

- Newton did not invent gravity.
- Scientists did not invent the truth.
- Scientists discover the truth and derive mathematical equations to describe the truth in formulated theory.
- The truth can then be applied to numerous observed data without making any mistake.**

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Bootstrap

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A3. Bootstrap (Estimation of SEs)
A3. 使用bootstrap技術估算標準誤 (SEs)

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Same bootstrap samples?
使用相同bootstrap樣本?

Same bootstrap samples =?

If and only if you have already run the bootstrap for this data file, you can use the same bootstrap samples for this run [Enter 2 and click on OK.] Attention! This good option should be used with caution. There are always variations among bootstraps. The larger B you use, the more stable results you will get. If you didn't run the bootstrap for the same data, you have to enter "1".

Do you want to use the same bootstrap samples (1=No, 2=Yes)

If it is the first time you analyze this data file, you have to enter 1.
第一次分析時必須選擇 1.

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Save all bootstrap table results? (Mostly NO)
保存所有bootstrap樣本的结果? (一般選擇No)

Detailed results?

Do you need the table of all bootstrap results?

If you choose "yes", you can see all results. But it takes disk space.

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Effective bootstrap only? (Mostly yes)
 只要有效bootstrap樣本? (一般選擇Yes)

Only effective bootstraps?
 Do you want only effective bootstrap results?

Yes No

In most cases, you choose Yes. If you want to see the non-effective bootstrap, choose No.

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Frequency chart (50 or 20 classes)頻度圖

More classes for frequency chart?
 Do you want to see more classes (Yes=50 classes, No=20 classes)?

Yes No

It is OK to choose Yes or No.

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Enter the number of bootstrap 輸入取樣次數

Bootstrap
 Enter the number of bootstrap (B <= 200,000).
 If you want to link life table and CONSUME, B must be <= 200,000.

100000

Note well! You have to use $B \geq 100,000$ to get stable estimates of population parameters.

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Enter the sample size 輸入樣本數

Sample size =?
 Enter the sample size (n) of bootstrap

50

In most cases, you just click OK. The program will use the number of individuals you used for life table study as sample size.

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Please wait! 請等候!

今日はもう休みましょう。
 Running bootstrap (Bd= 100000).
 Bootstrap began at:
 10/13/2020 12:11:18 AM
 Please wait! Don't touch me!
 1000
 Estimated total time: 82 m.
 After B>10,000, please wait for the results.

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Do you need life tables of 0.025 and 0.975 percentiles?
 (They give you the variability of your life table.)

Percentile life tables?
 Do you need life tables of 0.025 and 0.975 percentiles? (If and only if you used $B \geq 1000$, you can choose yes.) (In general, you choose "Yes")

Yes No

Note well! You have to use $B \geq 100,000$ to get reliable and stable percentiles.

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Quick sort or selection sort? 快速排序或挑選排序?

Running bootstrap

Sorting option (Bootstrap Intrinsic Rate)

Do you want to run Quicksort or Selection sort? Yes=Quicksort, No=Selection sort. If you encounter error when using Quicksort, please try Selection sort.

Yes No

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Enter quick sort classes 輸入快速排序組數

Running bootstrap (Rd= 100000)

Enter quicksort classes

Dear General user, Please select quicksort classes (2, 4, 8, 16, 32, 64 or 128). If sample size is small, you cannot use 128 classes. You have to use 16 classes.

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OK Cancel

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If you cannot use 128 classes, please use 32 or 16. 若不能使用128組，請重新分析，並使用較小組數。

Running bootstrap

Use fewer classes

You cannot use 128 classes. Please re-run this program and use a smaller classes.

OK Cancel

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Do you need bootstrap frequency files and normal curves?

Running bootstrap (Rd= 100000)

Normal density curve.

Do you need bootstrap frequency file and normal curves?

Yes No

In most cases, you choose No. If you want to prepare figures of the normal curves, you can choose Yes.

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End of bootstrap

Running bootstrap

Bootstrap began at: 10/13/2020 12:11:18 AM

Bootstrap ended at: 10/13/2020 1:33:31 AM

Total time =82 min.

Writing output files. Please wait for the R0 bar chart.

Quick sort: about 2 min.

Selection sort: 18 min.

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Congratulation!

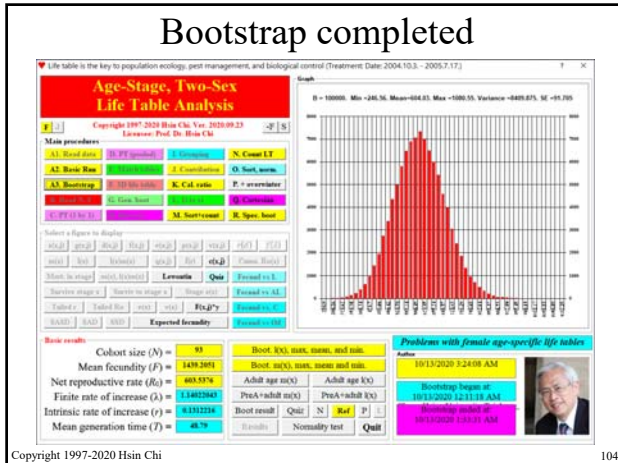
Task completed

Completed and congratulation! Please read C:\Users\Prof. Dr. Hsin Chi\Documents\2-teaching\000-Of- teaching\0-Theoretical Ecology\000-Life table examples\000-Example 1988 1d\Example_0A_Life table_Output.txt.

OK

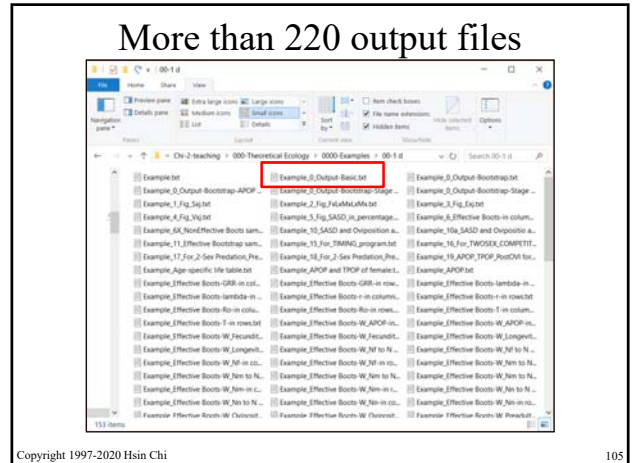
Life table analysis completed. Don't forget to read the output file (..._0a_Life table_Output.txt).

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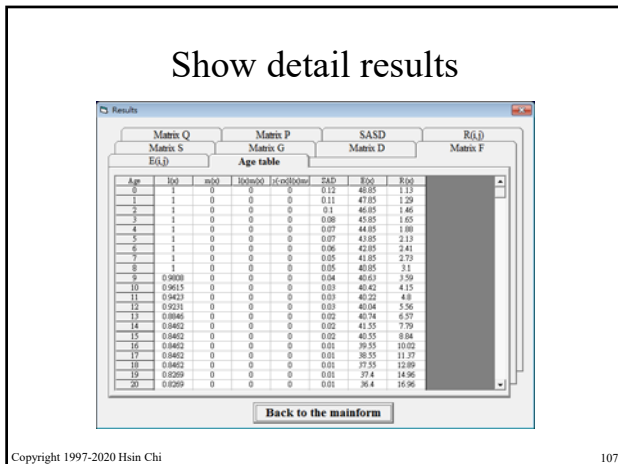
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Important! 重要提醒!

In the file “_0A_Life table_Output.txt” you can find all your data and analytical results. You must read this file carefully and to find important features of your data and to report them in your paper. You have to interpret your results based on life table theory.

在輸出檔“_0A_Life table_Output.txt”中，有你的資料與所有分析結果。請務必詳細閱讀，確實了解所有分析結果(實事求是)，並且將重要的與特別的結果在你的論文中依據生命表理論解釋闡述。

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How to read the _output.txt file

- To read the Example_output.txt file in aligned column format, you have to select **Courier New** font. (In general you don't need to change it).
- If the _output.txt is not in aligned format, then change Format – Font – Courier New.
- The data in Example_output.txt file contains limited digits. But in graphic text file (e.g., Example_sxj.txt), more digits are listed.

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File list 1

Example.txt
 Example_0A_Life Table_Output.txt
 Example_0B_Bootstrap_Output.txt
 Example_0C_Bootstrap_Stage mean_Output.txt
 Example_0D_Bootstrap_APOP and TPOP_Output.txt
 Example_0E_Bootstrap_Stage mortality_Output.txt
 Example_1_Fig_Sxj.txt
 Example_2_Fig_FxLxMxLxMx.txt
 Example_3_Fig_Exj.txt
 Example_4_Fig_Vxj.txt
 Example_5_Fig_SASD.txt
 Example_5_Fig_SASD_in_percentage.txt
 Example_6_Fig_Pxj.txt

Use this data for tables. 使用這些檔案列表。

Use these files to prepare your figures (SigmaPlot, Origin, Excel, etc). 使用這些檔案繪圖。

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If you report e_{xj} , you have to cite following reference

若你論文中報導 e_{xj} ,你必須引用下面文獻

- Chi, H. and H. Y. Su. 2006. Age-stage, two-sex life tables of *Aphidius gifuensis* (Ashmead) (Hymenoptera: Braconidae) and its host *Myzus persicae* (Sulzer) (Homoptera: Aphididae) with mathematical proof of the relationship between female fecundity and the net reproductive rate. *Environmental Entomology* 35: 10-21.

If you report v_{xj} , you have to cite following references

- Tuan, Shu-Jen, Chung-Chieh Lee and Hsin Chi. 2014a. Population and damage projection of *Spodoptera litura* (F.) on peanuts (*Arachis hypogaea* L.) under different conditions using the age-stage, two-sex life table. *Pest Manag. Sci.* 70: 805–813.
- Tuan, Shu-Jen, Chung-Chieh Lee and Hsin Chi. 2014b. Erratum: Population and damage projection of *Spodoptera litura* (F.) on peanuts (*Arachis hypogaea* L.) under different conditions using the age-stage, two-sex life table. *Pest Manag. Sci.* 70: 1936.

File list 2

Example_10_SASD and Oviposition age_for_CONSUME.txt
 Example_11_Bootstrap samples-date_2020912-time_15734.txt
 Example_15_For_TIMING_1 control.txt
 Example_15_For_TIMING_2 controls.txt
 Example_15_For_TIMING_2 Releases.txt
 Example_15_For_TIMING_3 controls.txt
 Example_15_For_TIMING_5-harvest.txt
 Example_16_For_TWSEX_COMPETITION_program.txt
 Example_17_For_2-Sex Predation_Predator data.txt
 Example_18_For_2-Sex Predation_Prey data.txt
 Example_19_APOP_TPOP_PostOVI for Consume.txt

Use this data for simulation.
 使用這些檔案
 模擬種群增長。

11_Bootstrap samples-datetxt
 This file contains bootstrap record, you can use this file to run A3 to get the same bootstrap results. 此檔案紀錄所有bootstrap的樣本，使用此檔案執行A3可以得到相同的結果。

File list 3

Example_Effect Boot-A1-R0.txt
 Example_Effect Boot-A2-R0-with serial nr.txt
 Example_Effect Boot-A3-r.txt
 Example_Effect Boot-A4-r-with serial nr.txt
 Example_Effect Boot-A5-lambda.txt
 Example_Effect Boot-A6-lambda-with serial nr.txt
 Example_Effect Boot-A7-T.txt
 Example_Effect Boot-A8-doubling time.txt
 Example_Effect Boot-A9-GRR.txt
 Example_Effect Boot-B1_Total longevity.txt
 Example_Effect Boot-B2_APOP.txt
 Example_Effect Boot-B3_TPOP.txt
 Example_Effect Boot-B5_Fecundity.txt

Use these files for paired test.
 使用這些檔案
 比較處理間之
 差異。

Please copy the following files to the respective folder:

..._0Hd_life Table_0.025_lambda-sample_67204.txt
 ..._0Hd_life table_0.975_lambda-sample_12332.txt

\\Desktop\Life table lecture-JAU\4-Life table examples\2-Life table 0.025
 \\Desktop\Life table lecture-JAU\4-Life table examples\3-Life table 0.975

File list 4

Example_Effect Boot-U1_Age of 0.5 lx.txt
 Example_Effect Boot-U2_lx-at age 21.txt
 Example_Effect Boot-V1_Peak Reproductive value.txt
 Example_Effect Boot-V2_Age of Peak Rep. value.txt
 Example_Effect Boot-W2_Fecundity (NFr).txt
 Example_Effect Boot-W2_Oviposition days.txt
 Example_Effect Boot-W3_Preadult survival.txt
 Example_Effect Boot-W4_Surv Prob to 1_Egg.txt
 Example_Effect Boot-W4_Surv Prob to 2_Larva.txt
 Example_Effect Boot-W4_Surv Prob to 3_Pupa.txt
 Example_Effect Boot-W4_Surv Prob to 4_Preadult.txt
 Example_Effect Boot-W4_Surv Prob to 5_Female.txt
 Example_Effect Boot-W4_Surv Prob to 6_Male.txt
 Example_Effect Boot-W4_Surv Prob to 7_Adult.txt

File list 5

Example_Effect Boot-W5_Stage-spec mort_1_Egg.txt
 Example_Effect Boot-W5_Stage-spec mort_2_Larva.txt
 Example_Effect Boot-W5_Stage-spec mort_3_Pupa.txt
 Example_Effect Boot-W6_Stage-spec surv_1_Egg.txt
 Example_Effect Boot-W6_Stage-spec surv_2_Larva.txt
 Example_Effect Boot-W6_Stage-spec surv_3_Pupa.txt
 Example_Effect Boot-W7_Mort distrib in_1_Egg.txt
 Example_Effect Boot-W7_Mort distrib in_2_Larva.txt
 Example_Effect Boot-W7_Mort distrib in_3_Pupa.txt
 Example_Effect Boot-W7_Mort distrib in_4_Preadult.txt
 Example_Effect Boot-W7_Mort distrib in_5_Female.txt
 Example_Effect Boot-W7_Mort distrib in_6_Male.txt
 Example_Effect Boot-W7_Mort distrib in_7_Adult.txt

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File list 6

Example_Effect Boot-W8_Nf to adults ratio.txt
 Example_Effect Boot-W8_Nf to N ratio.txt
 Example_Effect Boot-W8_Nf.txt
 Example_Effect Boot-W8_Nfr to N ratio.txt
 Example_Effect Boot-W8_Nfr to Nf ratio.txt
 Example_Effect Boot-W8_Nfr.txt
 Example_Effect Boot-W8_Nm to N ratio.txt
 Example_Effect Boot-W8_Nm to Nf ratio.txt
 Example_Effect Boot-W8_Nm.txt
 Example_Effect Boot-W8_Nn to N ratio.txt
 Example_Effect Boot-W8_Nn.txt

What is the definition of sex ratio?
 性比率之定義?

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File list 7

Example_Effect Boot-Y1_Egg-to-Larva.txt
 Example_Effect Boot-Y1_PreAdult time.txt
 Example_Effect Boot-Y1_Sex_F_Egg-to-Larva_Time.txt
 Example_Effect Boot-Y1_Sex_F_PreAd_Time.txt
 Example_Effect Boot-Y1_Sex_F_total longevity.txt
 Example_Effect Boot-Y1_total longevity.txt
 Example_Effect Boot-Y2_Sex_M_Egg-to-Larva_Time.txt
 Example_Effect Boot-Y2_Sex_M_PreAd_Time.txt
 Example_Effect Boot-Y2_Sex_M_total longevity.txt
 Example_Effect Boot-Y3_Sex_N_Egg-to-Larva_Time.txt

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File list 8

Example_Effect Boot-Z0_Stage mean_1_Egg.txt
 Example_Effect Boot-Z0_Stage mean_2_Larva.txt
 Example_Effect Boot-Z0_Stage mean_3_Pupa.txt
 Example_Effect Boot-Z0_Stage mean_4_Adult.txt
 Example_Effect Boot-Z1_Stage mean_Sex_F_1_Egg.txt
 Example_Effect Boot-Z1_Stage mean_Sex_F_2_Larva.txt
 Example_Effect Boot-Z1_Stage mean_Sex_F_3_Pupa.txt
 Example_Effect Boot-Z1_Stage mean_Sex_F_4_F adult.txt
 Example_Effect Boot-Z2_Stage mean_Sex_M_1_Egg.txt
 Example_Effect Boot-Z2_Stage mean_Sex_M_2_Larva.txt
 Example_Effect Boot-Z2_Stage mean_Sex_M_3_Pupa.txt
 Example_Effect Boot-Z2_Stage mean_Sex_M_4_M adult.txt
 Example_Effect Boot-Z3_Stage mean_Sex_N_1_Egg.txt
 Example_Effect Boot-Z3_Stage mean_Sex_N_2_Larva.txt

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Note well!

If you are using Turkish, Farsi, Chinese or other operation systems, you might see following problems in the files prepared by TWOSEX:

" "Project:Life table of Stethorus reared on the cowbean" "

"Next line is bootstrap sample size (n)"

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"Next line is total effective bootstrap number (B)"

100000

""""i""",103,15.9029126213592

You have to delete the extra double quotes manually.

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File list 9

Example_Fig Dxj.txt
 Example_Fig Ex.txt
 Example_Fig Exj.txt
 Example_Fig Fxj.txt
 Example_Fig Gxj.txt
 Example_Fig Lx.txt
 Example_Fig Mx.txt
 Example_Fig Nxj.txt
 Example_Fig Qxj.txt
 Example_Fig SAD.txt
 Example_Fig Uxj.txt
 Example_Fig Vx.txt

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File list 10

Example_G_APOP and TPOP of female.txt
 Example_G_APOP.txt
 Example_G_Egg per day during oviposition period.txt
 Example_G_Eggs per ovi-day for general boot.txt
 Example_G_Eggs per ovi-day_NOT for general boot.txt
 Example_G_Oviposition days.txt
 Example_G_Oviposition period.txt
 Example_G_Post-oviposition period.txt
 Example_G_total fecundity all females.txt
 Example_G_total fecundity of rep females.txt
 Example_G_Total longevity-all.txt
 Example_G_Total longevity-female.txt
 Example_G_Total longevity-Male.txt
 Example_G_Total longevity-N type.txt
 Example_G_TPOP.txt

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File list 11

Example_H_Stage duration-All adult.txt
 Example_H_Stage duration-Egg.txt
 Example_H_Stage duration-Female adult.txt
 Example_H_Stage duration-Larva.txt
 Example_H_Stage duration-Male adult.txt
 Example_H_Stage duration-Pupa.txt
 Example_H_Stage-Begin-End-duration-All adult.txt
 Example_H_Stage-Begin-End-duration-Egg.txt
 Example_H_Stage-Begin-End-duration-Female adult.txt
 Example_H_Stage-Begin-End-duration-Larva.txt
 Example_H_Stage-Begin-End-duration-Male adult.txt
 Example_H_Stage-Begin-End-duration-Pupa.txt
 Example_H_Stage-duration-Larva to Pupa_All sex.txt
 Example_H_Stage-duration-Larva to Pupa_All sex-row.txt
 Example_H_Stage-duration-preadult-all sexes.txt
 Example_H_Stage-duration-preadult-F.txt
 Example_H_Stage-duration-preadult-M.txt

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File list 12

Example_I1_Bootstrap_0.025 and 0.975 percentile-R0.txt
 Example_I1_Bootstrap_R0_Cumu Freq.txt
 Example_I1_Bootstrap_Sorted R0.txt
 Example_I1_Bootstrap_Sorted R0_counts.txt
 Example_I2_Bootstrap_0.025 and 0.975 percentile-lambda.txt
 Example_I2_Bootstrap_Sorted lambda.txt
 Example_I2_Bootstrap_Sorted lambda_counts.txt
 Example_I3_Bootstrap_0.025 and 0.975 percentile-r.txt
 Example_I3_Bootstrap_Sorted r.txt
 Example_I3_Bootstrap_Sorted r_counts.txt
 Example_I4_Bootstrap_0.025 and 0.975 percentile-T.txt
 Example_I4_Bootstrap_Sorted T.txt
 Example_I5_Bootstrap_0.025 and 0.975 percentile-GRR.txt
 Example_I5_Bootstrap_Sorted GRR.txt

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File list 13

Example_J_Group-reared life table-4 stages.txt
 Example_J1_Bootstrap_Sorted Fecundity.txt
 Example_J1_Bootstrap_Sorted Fecundity_counts.txt
 Example_J1_Bootstrap_Sorted Female proportion.txt
 Example_J1_Bootstrap_Sorted Longevity.txt
 Example_Ka_boot_0.025 lambda-sample_63625.txt
 Example_Ka_boot_0.975 lambda-sample_50200.txt
 Example_Kb_boot_0.025 r-sample_63625.txt
 Example_Kb_boot_0.975 r-sample_50200.txt
 Example_Kc_boot_0.025 R0-sample_18321.txt
 Example_Kc_boot_0.975 R0-sample_6658.txt

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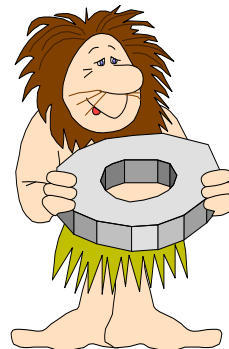
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File list 14

Example_Kd_Life Table_0.025 lambda-sample_63625.txt
 Example_Kd_Life Table_0.975 lambda-sample_50200.txt
 Example_Ke_Life Table_0.025 r-sample_63625.txt
 Example_Ke_Life Table_0.975 r-sample_50200.txt
 Example_Kf_Life Table_0.025 R0-sample_18321.txt
 Example_Kf_Life Table_0.975 R0-sample_6658.txt
 Example_StageRawData.txt
 Example_Stage-Raw-data-row.txt
 Example_Z-R0 and boot SE for harvest.txt
 Example_ZZ-population parameters.txt

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Teşekkür ederim!

سپاسگزارم

謝謝!

ขอบคุณครับ

Děkuji

Danke!

¡Muchas gracias!

Thank you!

ご清聴ありがとうございます！

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