ADE-4

Correspondence analysis

Abstract

This volume describes the computation and usual graphical display of a correspondence analysis processed on bird count data (Auda, Y., & al., 1983, La dispersion spatiale des Oiseaux au cours du cycle annuel : deux méthodes de description graphique. *Compte rendu hebdomadaire des séances de l'Académie des sciences*. Paris, D : III, 297, 387-392).

Contents

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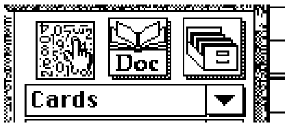
1 - Data input

The data used to illustrate this analysis were recorded by Hoffmann (1960)[1], analysed by Lebreton (1973)[2] and used to illustrate properties of correspondence analysis by Auda *et al.* [3].

The data set describes the recapture of teals (*Anas C. Creca* L.) in 14 areas of Europe. These birds were marked with rings. Samples were taken monthly from July to June.



Create a data folder and go to the **ADE-4•Data** selection card. Select «Sarcelles» in the right-hand data menu. The corresponding card shows up as follows:

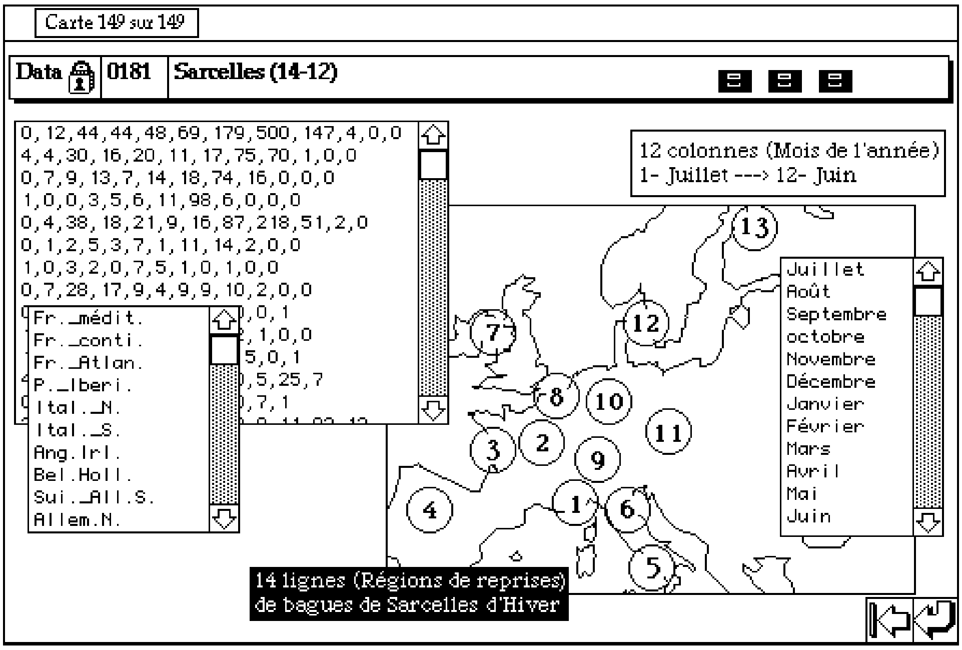


Table 1 Bird count data set.

	07	08	09	10	11	12	01	02	03	04	05	06	
1	0	12	44	44	48	69	179	500	147	4	0	0	*1047*
2	4	4	30	16	20	11	17	75	70	1	0	0	*248*
3	0	7	9	13	7	14	18	74	16	0	0	0	*158*
4	1	0	0	3	5	6	11	98	6	0	0	0	*130*
5	0	4	38	18	21	9	16	87	218	51	2	0	*464*
6	0	1	2	5	3	7	1	11	14	2	0	0	*46*
7	1	0	3	2	0	7	5	1	0	1	0	0	*20*
8	0	7	28	17	9	4	9	9	10	2	0	0	*95*
9	0	4	8	12	2	3	5	5	1	0	0	1	*41*
10	1	12	20	13	9	2	0	0	2	1	0	0	*60*
11	1	43	31	7	2	1	1	1	4	5	0	1	*97*
12	4	68	53	15	3	0	0	0	0	5	25	7	*180*
13	0	14	3	0	0	0	0	0	0	0	7	1	*25*
14	3	184	105	34	5	0	0	0	0	11	83	13	*438*
	15	*360*	*374*	*199*	*134*	*133*	*262*	*861*	*488*	*83*	*117*	*23*	*3049*

Copy the data as usual. The three following files should be copied: `Sar.edit`, `Code_Mois3` and `Code-Reg`.

`Sar.edit` contents the number of returned rings in each location for the 12 months sampling period (Table 1, numbers in italic indicate therow and column totals).

`Code_Mois3` contents the names of the sampling months.

`Code-Reg` contents the names of the regions where the samples were taken.

2 - Definition of the geographical space

Use **Copy files** from the **Data Folder** menu to copy files `Sarcelles_Carto` and `Sarcelles_Digi` (Fig. 1). These two files have a PICT format and must remain in PICT format to be used by ADE modules.

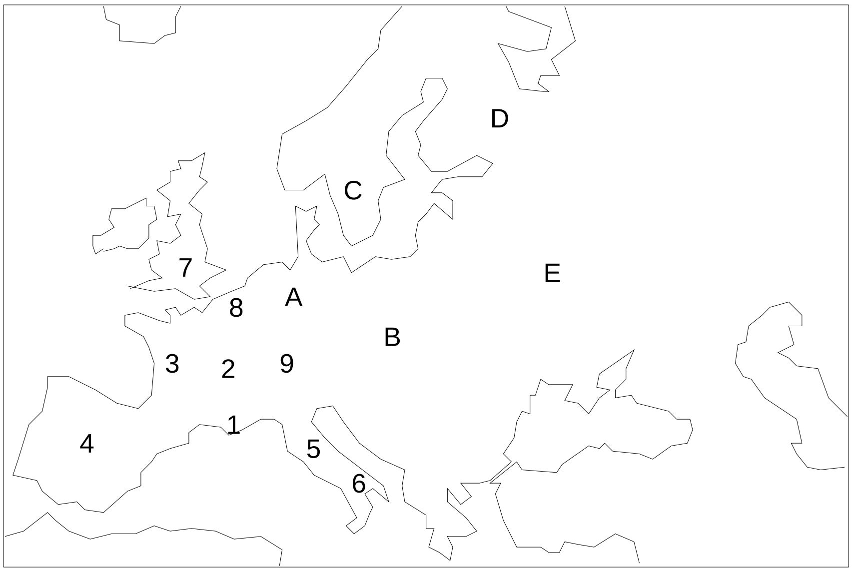
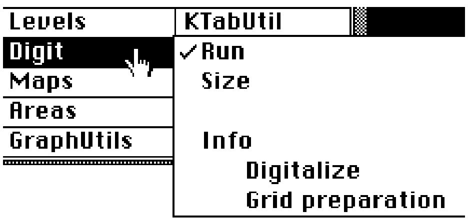
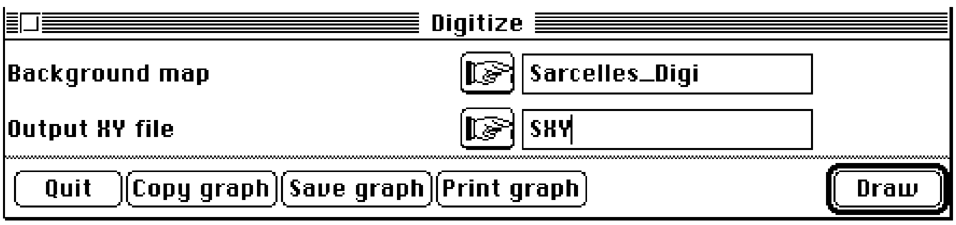


Figure 1 Content of file `Sarcelles_Digi`. Characters (1,2...E) on the geographical map locate the center of the sampling regions.

Use the **Digitalize** option of the **Digit** module to create the file that contains the spatial coordinates of each site as follows (see section -2.2 for more details):





Choose the file `Sarcelles_Digi` as background map and type in `SXY` into the **Output XY file** box (i.e., file that contains the spatial coordinates).

The output file has 14 rows (sites) and 2 columns. Open it to verify its content:

```
Input file: SXY
Row: 14 Col: 2

   1 |  87.0000 | 55.0000 |
   2 |  84.0000 | 75.0000 |
   3 |  63.0000 | 77.0000 |
   4 |  31.0000 | 47.0000 |
   5 | 116.0000 | 45.0000 |
   6 | 133.0000 | 31.0000 |
   7 |  68.0000 |113.0000 |
   8 |  87.0000 | 98.0000 |
   9 | 107.0000 | 77.0000 |
  10 | 109.0000 |102.0000 |
  11 | 146.0000 | 87.0000 |
  12 | 130.0000 |143.0000 |
  13 | 185.0000 |169.0000 |
  14 | 206.0000 |111.0000 |
```

Values are given in pixels.

3 - Correspondence analysis

3.1 - The mathematical principle

Initially proposed by Hirschfeld (1935)[4], and though long neglected (Hill, 1974)[5], correspondence analysis is a very widely used ordination technique (e.g., Greenacre and Vrba, 1984)[6]. Furthermore, Thioulouse and Chessel (1992)[7] have described its joint property of reciprocal averaging (Hill, 1973)[8] and dual scaling. Williams (1952)[9] underscored that correspondence analysis was a mean of measuring a correlation within a contingency table (see volume 4).

Let $\mathbf{L} = [n_{ij}]$ be a table having I rows (sampling units) and J columns (species). Let n_{ij}, for $1 \le i \le I$ and $1 \le j \le J$, be the abundance of the j*th* species in the i*th* sampling unit. Moreover, let $n_{i.} = \sum_{j=1}^{J} n_{ij}$, $n_{.j} = \sum_{i=1}^{I} n_{ij}$, and $n_{..} = \sum_{i=1}^{I} n_{i.} = \sum_{j=1}^{J} n_{.j}$ be, respectively, the row totals, the column totals, and the grand total.

Table $\mathbf{P} = [p_{ij}]$ of relative frequencies has I rows (sampling units) and J columns (species) with p_{ij} being the proportion of the cell n_{ij} as follows:

$$p_{ij} = \frac{n_{ij}}{n_{..}} \text{ for } 1 \le i \le I \text{ and } 1 \le j \le J$$

The row and column weights are respectively denoted by $p_{i.} = \frac{n_{i.}}{n_{..}}$ and $p_{.j} = \frac{n_{.j}}{n_{..}}$. Let $\mathbf{D}_I = \mathrm{Diag}\left(p_{1.},\ldots,p_{i.},\ldots,p_{I.}\right)$ and $\mathbf{D}_J = \mathrm{Diag}\left(p_{.1},\ldots,p_{.j},\ldots p_{.J}\right)$ be respectively the diagonal matrices of row weights and column weights. Let $\mathbf{x}$ be a vector (I

components) associated with the sampling units of $\mathbf{L}$ and let $\mathbf{y}$ be a vector (J components) associated with the species of $\mathbf{L}$.

Let $\mathbf{X} = \left[x_{ij} \right] = \mathbf{D}_I^{-1} \mathbf{P} \mathbf{D}_J^{-1} - \mathbf{1}_{IJ}$ with x_{ij} being a value as follows:

$$x_{ij} = \frac{p_{ij}}{p_{i.} p_{.j}} - 1$$

Let define $\mathbf{u}_1$ (first principal axis) as a vector in R^p solution of the equation

$$\mathbf{X}^t \mathbf{D}_I \mathbf{X} \mathbf{D}_J \mathbf{u}_1 = \lambda \mathbf{u}_1 \text{ with } \mathbf{u}_1^t \mathbf{D}_J \mathbf{u}_1 = 1$$

with λ (first eigenvalue) being maximum. The first row scores in R^p are derived from this equation and are equal to $\mathbf{R} = \mathbf{X}\ \mathbf{D}_p \mathbf{u}_1$. This procedure is symmetric (duality) and one can define $\mathbf{v}_1$ (first principal component) as a vector in R^n solution of the equation

$$\mathbf{X} \mathbf{D}_p \mathbf{X}^t \mathbf{D}_n \mathbf{v}_1 = \lambda \mathbf{v}_1 \text{ with } \mathbf{v}_1^t \mathbf{D}_n \mathbf{v}_1 = 1$$

with λ (first eigenvalue) being maximum. The corresponding first column scores in R^n are equal to $\mathbf{C} = \mathbf{X}^t \mathbf{D}_n \mathbf{v}_1$.

3.2 - Computation

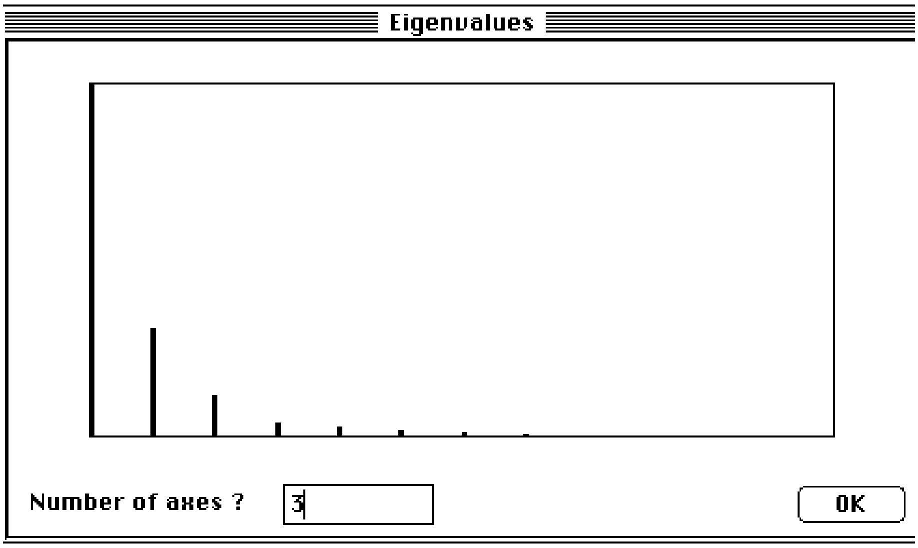
Transform the `Sar.edit` file into a binary file (`Sar`) using the **Text->Binary** option of the **TextToBin** module. Select **COA** popmenu of the **ADE•Base** selection menu and **Run** the module:

The eigenvalues, the inertia ratio of each axis, and the cumulated inertia shows up as follows:

Eigenvalues

Num.	Eigenval.	%Iner.	R.Sum	Num.	Eigenval.	%Iner.	R.Sum
01	+6.6759E-01	+0.6488	+0.6488	02	+2.0547E-01	+0.1997	+0.8485
03	+7.8334E-02	+0.0761	+0.9246	04	+2.5641E-02	+0.0249	+0.9495
05	+1.8508E-02	+0.0180	+0.9675	06	+1.3187E-02	+0.0128	+0.9803
07	+9.6811E-03	+0.0094	+0.9897	08	+6.1038E-03	+0.0059	+0.9957
09	+3.2126E-03	+0.0031	+0.9988	10	+8.7743E-04	+0.0009	+0.9996
11	+3.8148E-04	+0.0004	+1.0000	12	+0.0000E+00	+0.0000	+1.0000

Click **OK** to get the eigenvalues graph. Preserve three axes as follows:



Save the listing to store information about the results of this computation:

```
fc/COA: Correspondance analysis
Input file: Sar
Number of rows: 14, columns: 12
File Sar.fcpl contains the edge distribution of rows
It has 14 rows and 1 column
File Sar.fcpc contains the edge distribution of columns
It has 12 rows and 1 column
File Sar.fcta contains the doubly centred table DI-1*P*DJ-1 -1I*1J'
It has 14 rows and 12 columns
File Sar.fcma contains:
     the number of rows: 14
     the number of columns: 12
     the total number: 3049
----------------------------------------------------
DiagoRC: General program for two diagonal inner product analysis
Input file: Sar.fcta
--- Number of rows: 14, columns: 12
-----------------------
Total inertia:  1.02898
-----------------------
Num. Eigenval.   R.Iner.  R.Sum    |Num. Eigenval.   R.Iner.  R.Sum  |
01   +6.6759E-01 +0.6488 +0.6488   |02   +2.0547E-01 +0.1997 +0.8485 |
03   +7.8334E-02 +0.0761 +0.9246   |04   +2.5641E-02 +0.0249 +0.9495 |
05   +1.8508E-02 +0.0180 +0.9675   |06   +1.3187E-02 +0.0128 +0.9803 |
07   +9.6811E-03 +0.0094 +0.9897   |08   +6.1038E-03 +0.0059 +0.9957 |
09   +3.2126E-03 +0.0031 +0.9988   |10   +8.7743E-04 +0.0009 +0.9996 |
11   +3.8148E-04 +0.0004 +1.0000   |12   +0.0000E+00 +0.0000 +1.0000 |
File Sar.fcvp contains the eigenvalues and relative inertia for each
axis
--- It has 12 rows and 2 columns

File Sar.fcco contains the column scores
--- It has 12 rows and 3 columns
File :Sar.fcco ---------- Minimum/Maximum ----------
Col.:  1 Mini = -1.72343 Maxi = 0.661126
Col.:  2 Mini = -0.428492   Maxi =    1.265
Col.:  3 Mini = -0.571144   Maxi =  0.68004

File Sar.fcli contains the row scores
--- It has 14 rows and 3 columns
File :Sar.fcli ---------- Minimum/Maximum ----------
Col.:  1 Mini =  -1.7643 Maxi = 0.734438
```

```
Col.:  2 Mini = -0.612134   Maxi = 0.958164
Col.:  3 Mini = -1.00423  Maxi =  0.81009
----------------------------------------------------
```

The file `SAR.fcta` contains the values $[p_{ij}/(p_{i.}*p_{.j})]-1$ which measure the distance between the observed frequency in the *ith* region i for the *jth* month and the expected frequency given by the independence model between the variables "space" (rows) and "time" (columns). These values are computed as follows: $[(a_{ij}*a_{..})/(a_{i.}*a_{.j})] - 1$ where a_{ij} is the observed value, $a_{i.}$ the row totals, $a_{.j}$ the column totals, $a_{..}$ the total number of recaptured Teals (3049). For instance, (12*3049)/(1047*360) - 1 = -0.903 (row 1 and column 2). You can edit the file `SAR.fcta` to verify its contents:

```
Input file: Sar.fcta
Row: 14 Col: 12

   1 |  -1.0000 | -0.9029 | -0.6574 | -0.3561 |  0.0432 |  0.5108 |
0.9896 |  0.6911 | -0.1228 | -0.8597 | -1.0000 | -1.0000 |
   2 |   2.2785 | -0.8634 | -0.0138 | -0.0115 |  0.8350 |  0.0168 |
-0.2023 |  0.0709 |  0.7635 | -0.8519 | -1.0000 | -1.0000 |
   3 |  -1.0000 | -0.6248 | -0.5356 |  0.2606 |  0.0081 |  1.0313 |
0.3258 |  0.6586 | -0.3673 | -1.0000 | -1.0000 | -1.0000 |
   4 |   0.5636 | -1.0000 | -1.0000 | -0.6464 | -0.1249 |  0.0581 |
-0.0153 |  1.6695 | -0.7116 | -1.0000 | -1.0000 | -1.0000 |
   5 |  -1.0000 | -0.9270 | -0.3323 | -0.4056 |  0.0298 | -0.5553 |
-0.5987 | -0.3360 |  1.9355 |  3.0377 | -0.8877 | -1.0000 |
   6 |  -1.0000 | -0.8159 | -0.6455 |  0.6654 |  0.4839 |  2.4886 |
-0.7470 | -0.1532 |  0.9016 |  0.5972 | -1.0000 | -1.0000 |
   7 |   9.1633 | -1.0000 |  0.2229 |  0.5322 | -1.0000 |  7.0237 |
1.9094 | -0.8229 | -1.0000 |  0.8367 | -1.0000 | -1.0000 |
   8 |  -1.0000 | -0.3759 |  1.4028 |  1.7418 |  1.1556 | -0.0347 |
0.1025 | -0.6645 | -0.3423 | -0.2266 | -1.0000 | -1.0000 |
   9 |  -1.0000 | -0.1737 |  0.5907 |  3.4844 |  0.1099 |  0.6774 |
0.4192 | -0.5681 | -0.8476 | -1.0000 | -1.0000 |  2.2333 |
  10 |   2.3878 |  0.6939 |  1.7175 |  2.3197 |  2.4131 | -0.2358 |
-1.0000 | -1.0000 | -0.7917 | -0.3878 | -1.0000 | -1.0000 |
  11 |   1.0955 |  2.7545 |  1.6054 |  0.1057 | -0.5309 | -0.7637 |
-0.8800 | -0.9635 | -0.7424 |  0.8936 | -1.0000 |  0.3667 |
  12 |   3.5170 |  2.1996 |  1.4004 |  0.2768 | -0.6208 | -1.0000 |
-1.0000 | -1.0000 | -1.0000 |  0.0204 |  2.6194 |  4.1553 |
  13 |  -1.0000 |  3.7429 | -0.0217 | -1.0000 | -1.0000 | -1.0000 |
-1.0000 | -1.0000 | -1.0000 | -1.0000 |  6.2968 |  4.3026 |
  14 |   0.3922 |  2.5579 |  0.9543 |  0.1893 | -0.7403 | -1.0000 |
-1.0000 | -1.0000 | -1.0000 | -0.0774 |  3.9383 |  2.9346 |
```

The two files `SAR.fcpl` and `SAR.fcpc` are the rows frequencies used as rows weights and the columns frequencies used as columns weights respectively (i.e., 1047/3049=0.3434 and 15/3049=0.0049):

```
----------------------          ----------------------
Input file: Sar.fcpl            Input file: Sar.fcpc
Row: 14 Col: 1                  Row: 12 Col: 1

   1 |   0.3434 |                  1 |   0.0049 |
   2 |   0.0813 |                  2 |   0.1181 |
   3 |   0.0518 |                  3 |   0.1227 |
   4 |   0.0426 |                  4 |   0.0653 |
   5 |   0.1522 |                  5 |   0.0439 |
   6 |   0.0151 |                  6 |   0.0436 |
   7 |   0.0066 |                  7 |   0.0859 |
   8 |   0.0312 |                  8 |   0.2824 |
   9 |   0.0134 |                  9 |   0.1601 |
  10 |   0.0197 |                 10 |   0.0272 |
```

```
         11 |    0.0384 |
         12 |    0.0075 |
      ----------------------
```

```
  11 |    0.0318 |
  12 |    0.0590 |
  13 |    0.0082 |
  14 |    0.1437 |
----------------------
```

File `SAR.fcvp` contains the eigenvalues and relative inertia for each axis:

```
-------------------------------------------------
Input file: Sar.fcvp
Row: 12 Col: 2

   1 |    0.6676 |  0.6488 |
   2 |    0.2055 |  0.1997 |
   3 |    0.0783 |  0.0761 |
   4 |    0.0256 |  0.0249 |
   5 |    0.0185 |  0.0180 |
   6 |    0.0132 |  0.0128 |
   7 |    0.0097 |  0.0094 |
   8 |    0.0061 |  0.0059 |
   9 |    0.0032 |  0.0031 |
  10 |    0.0009 |  0.0009 |
  11 |    0.0004 |  0.0004 |
  12 |    0.0000 |  0.0000 |
-------------------------------------------------
```

The first column of this file is used to plot the eigenvalues graph. Note that the three first axes take into account 92.5 % of the total inertia of the table. Files `SAR.fcco` and `SAR.fcli` contain the column scores and the row scores respectively. They can be used to draw factorial maps.

The inertia analysis allows to add statistical aid in the interpretation of data (see section-2.2 for more details concerning the significance of the resulting values). Use **DDUtil** and choose the **Rows: Inertia analysis** option to compute the row contributions as follows:


```
Input file: Sar.fcta
Number of rows: 14, columns: 12

Inertia: Two diagonal norm inertia analysis
Total inertia:  1.02898 - Number of axes: 3

File Sar.fccl contains the contribution of rows to the trace
It has 14 rows and 1 column
Row inertia
All contributions are in 1/10000

----------Absolute contributions----------
|Num  |Fac 1|Fac 2|Fac 3|
|    1| 1824| 1593|  141|
|    2|  160|  171|  247|
|    3|  158|  311|   29|
|    4|  344|  777|  456|
|    5|  338| 6799|  478|
|    6|   38|   92|   75|
```

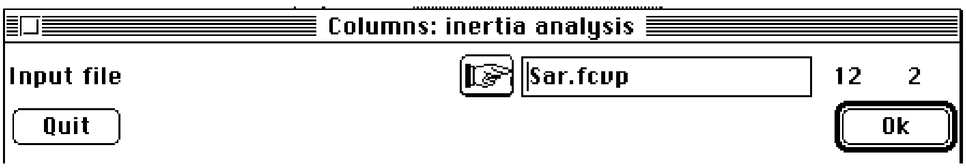
7	6	40	543
8	13	17	2317
9	8	30	1231
10	119	12	2533
11	541	21	468
12	1591	10	8
13	382	34	686
14	4470	85	780

----------Relative contributions----------

Num	Fac 1	Fac 2	Fac 3	Remains	Weight	Cont.
1	7686	2066	70	177	3433	1539
2	4286	1409	773	3530	813	243
3	5612	3397	124	865	518	182
4	4451	3092	691	1764	426	502
5	1356	8381	224	37	1521	1620
6	2514	1839	570	5075	150	100
7	186	362	1864	7586	65	221
8	417	160	8189	1232	311	215
9	375	396	6034	3193	134	155
10	2571	84	6403	941	196	301
11	6549	79	665	2706	318	536
12	9675	19	6	298	590	1067
13	7726	217	1628	427	81	321
14	9691	56	198	53	1436	2992

In these tables, the column "Num" identifies the rows (14 sites) or the columns (12 months). The highest values of relative contributions are underlined to highlight the significance of factorial scores.

Choose the **Columns: Inertia analysis** option to compute the column contributions as follows:



Column inertia
All contributions are in 1/10000

----------Absolute contributions----------

Num	Fac 1	Fac 2	Fac 3
1	39	1	141
2	3656	118	201
3	975	60	1855
4	61	0	2717
5	52	21	785
6	201	207	445
7	498	767	26
8	1848	1714	967
9	646	4892	347
10	2	2120	145
11	1707	77	2265
12	310	17	99

----------Relative contributions----------

Num	Fac 1	Fac 2	Fac 3	Remains	Weight	Cont.

1	2129	19	900	6951	49	119
2	9630	95	62	211	1180	2463
3	7781	148	1737	332	1226	813
4	1305	5	6790	1898	652	304
5	2330	291	4076	3301	439	146
6	3642	1157	946	4252	436	358
7	5609	2661	35	1693	859	576
8	7213	2059	442	284	2823	1662
9	2915	6795	184	104	1600	1437
10	33	8539	223	1203	272	495
11	7995	112	1244	647	383	1385
12	8534	144	320	999	75	236

4 - Data cartography

Use the **Maps** module with the **Values** option to plot the scores on the geographic map already prepared:

Use the file `Sarcelles-carto` as **Background map (Pict file)**, `SXY` as **XY file,** `Code_mois3` as **Label file** and `Sar` as **Input data file**. If necessary, modify the G value (**Min & Max. selection** in the **Windows** menu) to obtain the desired diameter of circles. This results in Fig. 2.

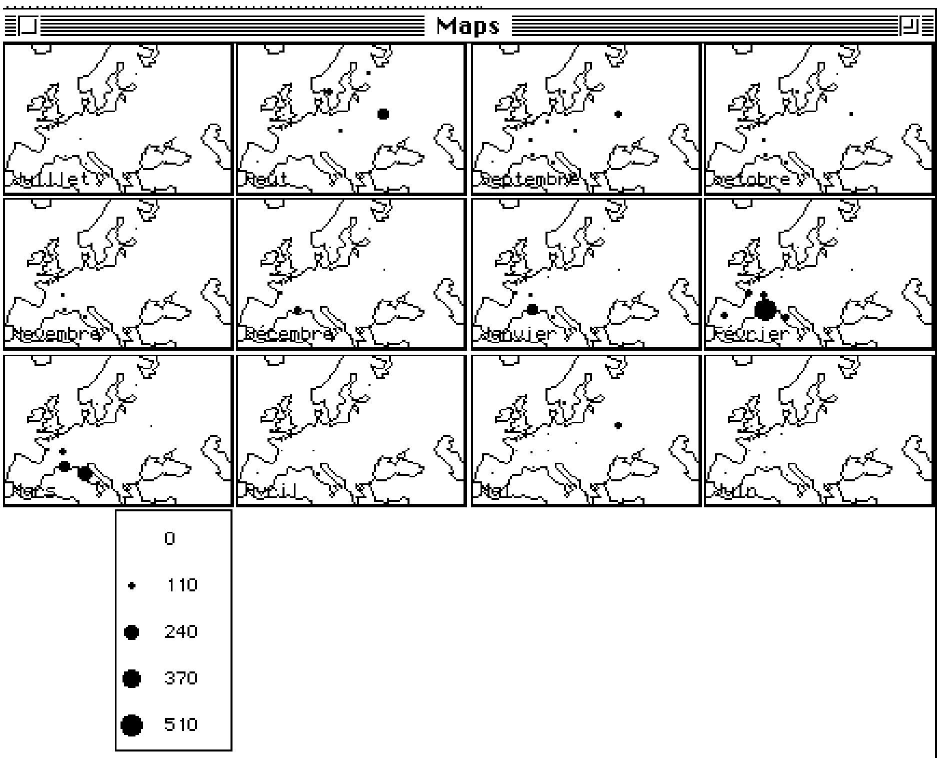


Figure 2 Cartography of the abundance of teals at each sampling date (data from `Sar`*).*

In this representation, the circle size is calibrated from the maximum value. Consequently, it is more relevant to draw the frequencies distributions per date (data in percentage per column). Threfore, you can transform file `Sar` into a file containing frequencies distributions per date (`SarPCC`).

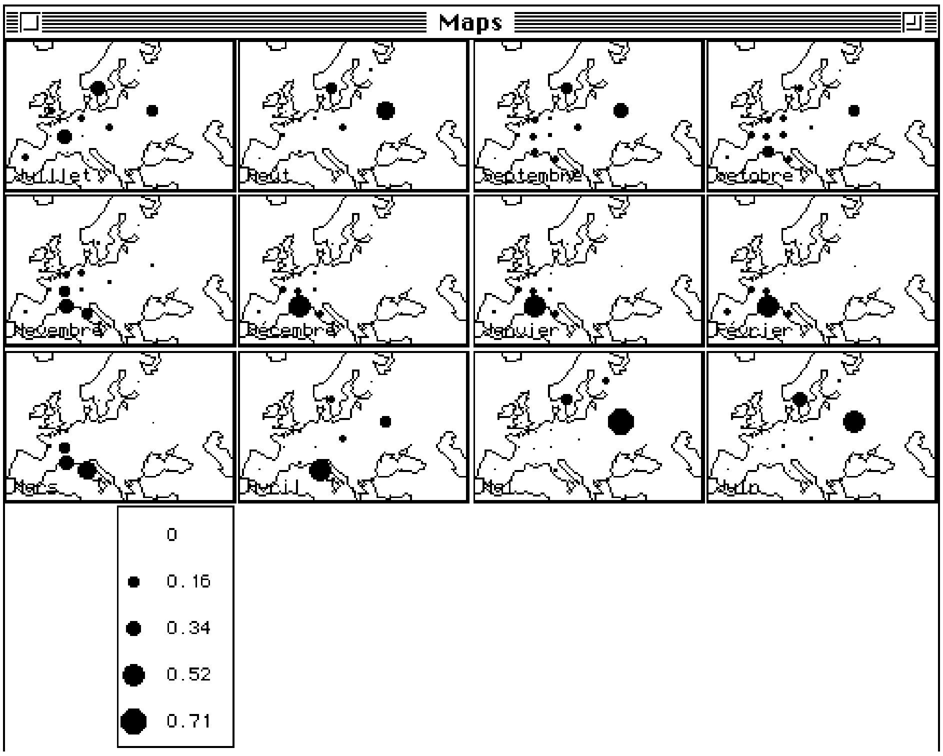
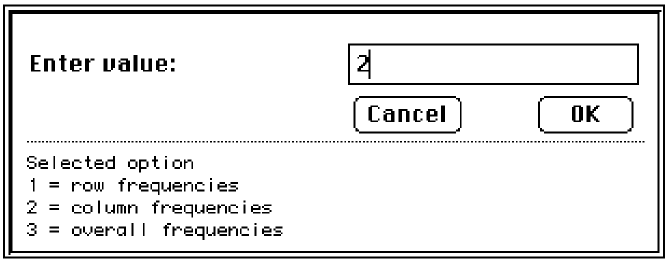
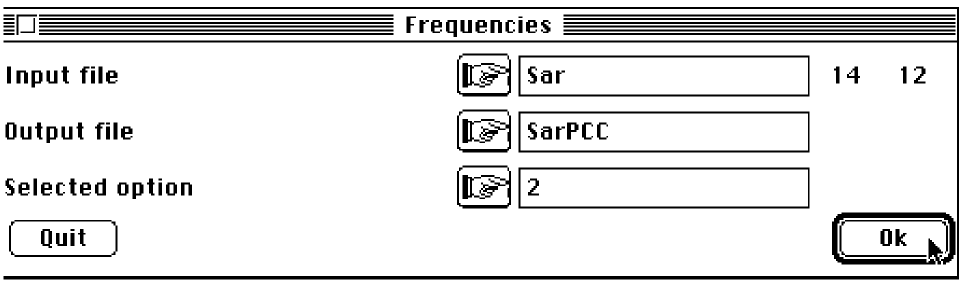


Figure 3 Cartography of the frequency distributions of teals at each sampling date (data from `SarPCC`).

Use the **Bin->Bin** module with the **Frequencies** option. Choose `Sar` as **Input file** and type `SarPCC` as **Output file** and click the hand icon. Choose option 2:



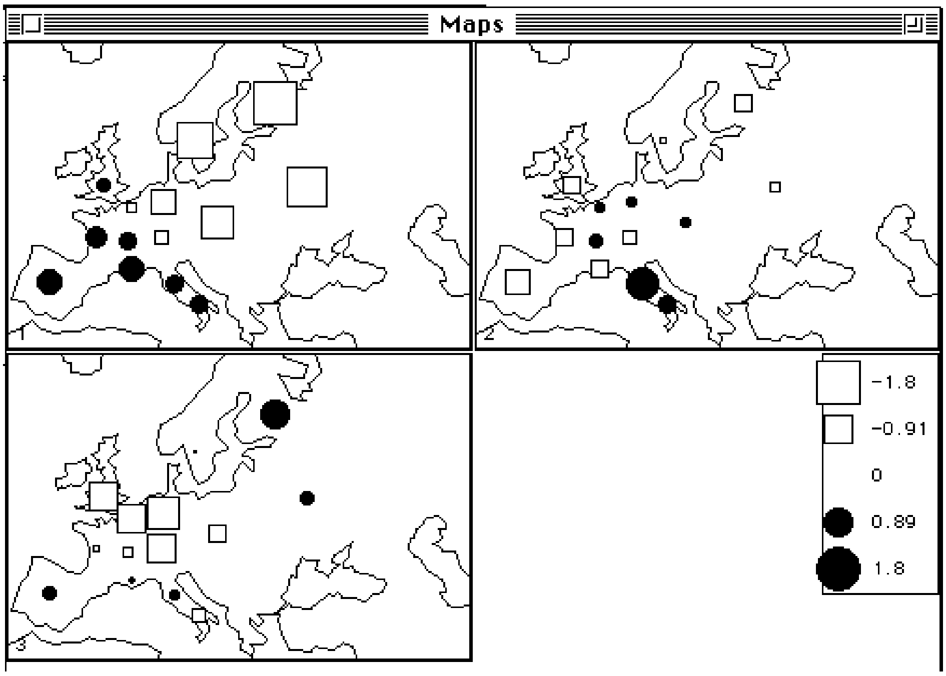



```
Input file: Sar
--- Number of rows: 14, columns: 12
----------------------------------
```

```
Transformation X -> X / column sum
----------------------------------
Output file: SarPCC
--- Number of rows: 14, columns: 12
```

Run again the **Maps** module (**Values** option) and use `SarPCC` as **Input data file**. This results in Fig. 3.

These graphs show the dispersion of teals according to the season: a wide spatial distribution in summering periods (July-September and May-June) and a decrease in distribution during wintering periods (gregariousness from December to March) after the automn migration. The migration loop occurs as follows: teals start from their summering areas to wintering areas through the north of Europe and come back by the south of Europe.



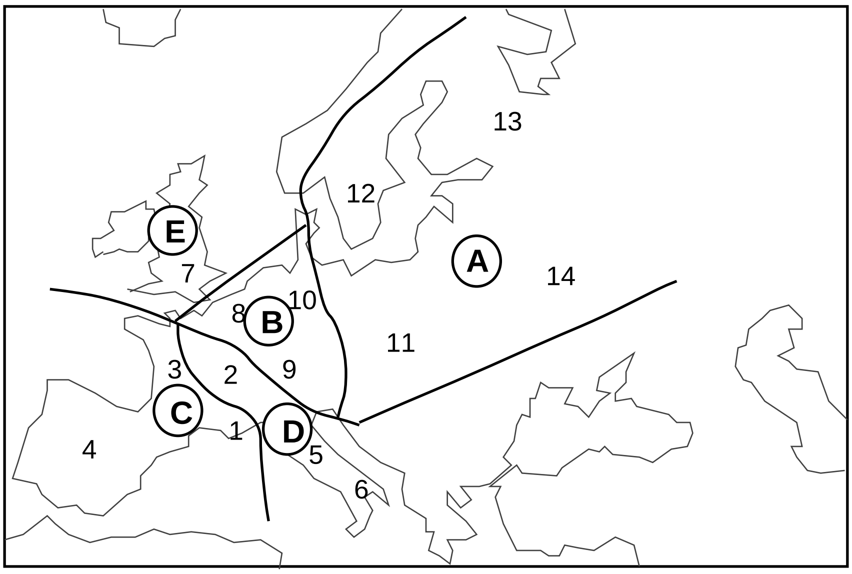
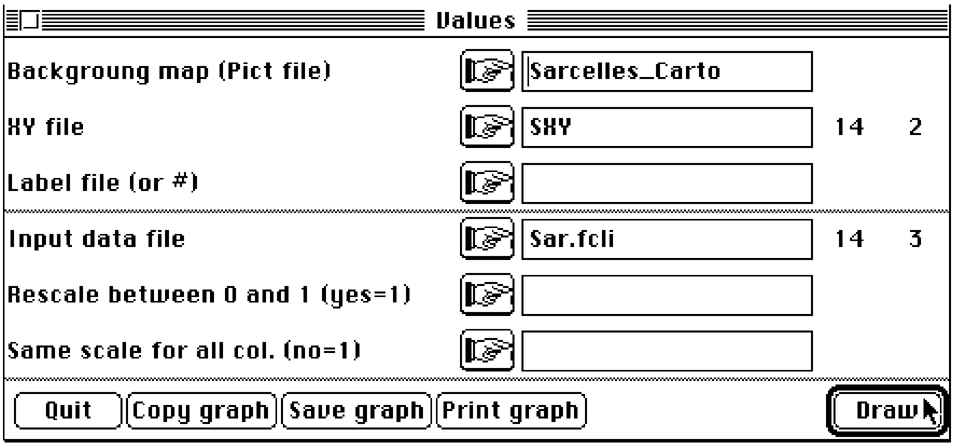


Figure 4 Spatial typology of teals distribution resulting from the correspondence analysis scores.

5 - Cartography of factorial scores

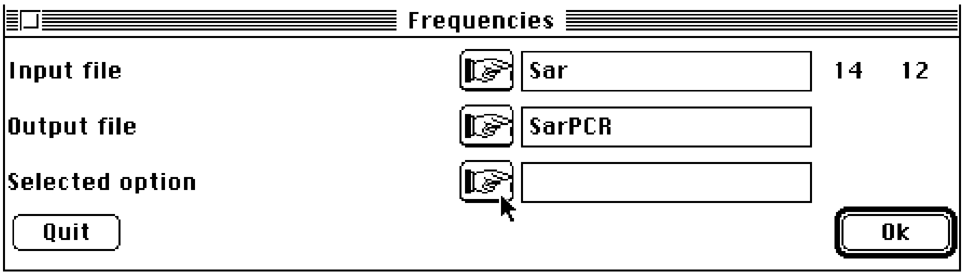
Spatio-temporal correspondences can be shown by ploting the factorial scores on each axis on the geographic map. Use again the **Maps** module (**Values** option) and use `Sar.fcli` as **Input data file:**

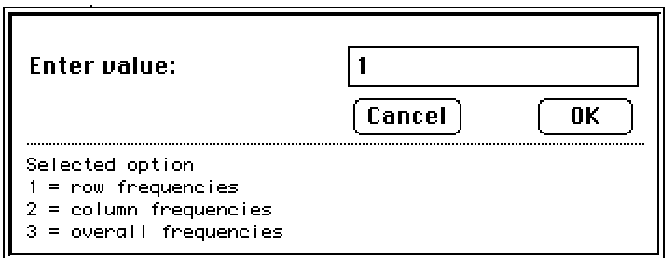


This results in the following graph which leads to the partition of the studied area into five zones (Fig. 4).

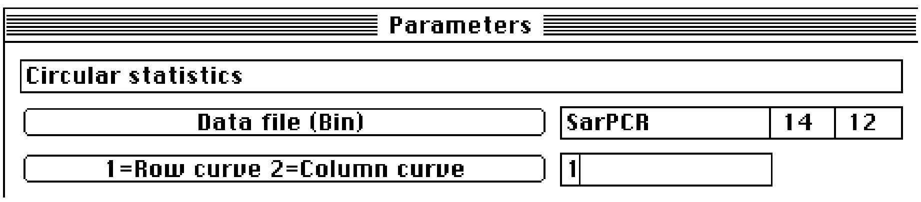
6 - Plotting circular data (see Graph1D : Stars)

Use the **Bin->Bin** module (**Frequencies** option) to obtain the frequencies distributions by row. Choose `Sar` as **Input file** and `SarPCR` as **Output file**, and the first option.





Go to the **ADE•Old** selection card and select the **CircleChart** Basic program. Fill in the dialog boxes as follows:



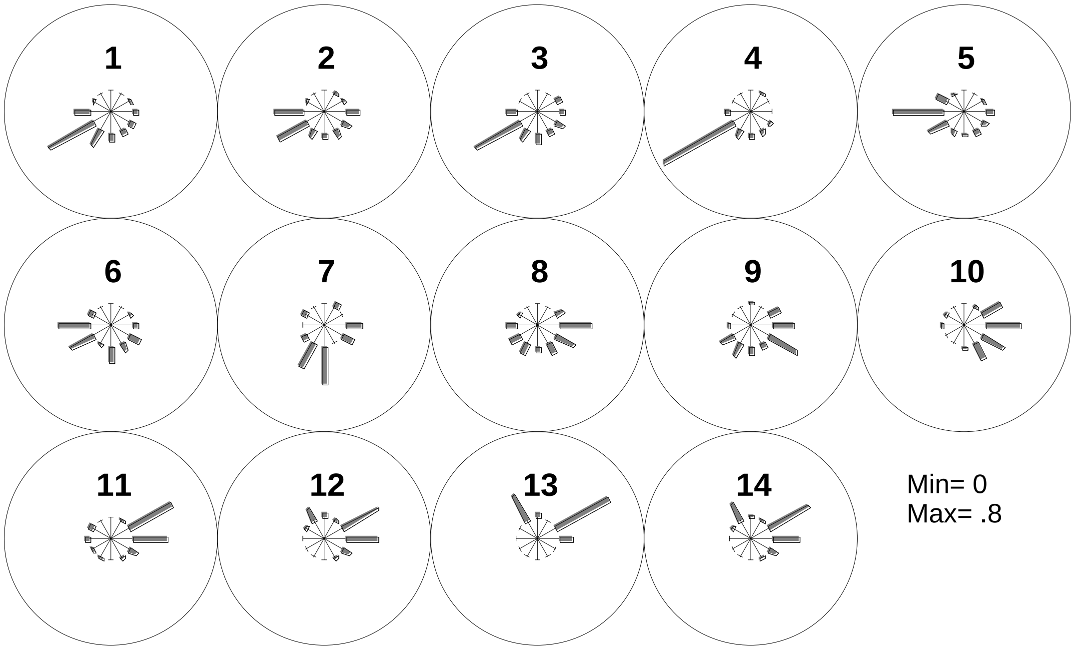


Figure 5 Circle diagram of the percentages of recaptures per month for each site. The circles are divided into 12 parts and the length of the thick grey lines is proportional to the percentages of recaptures

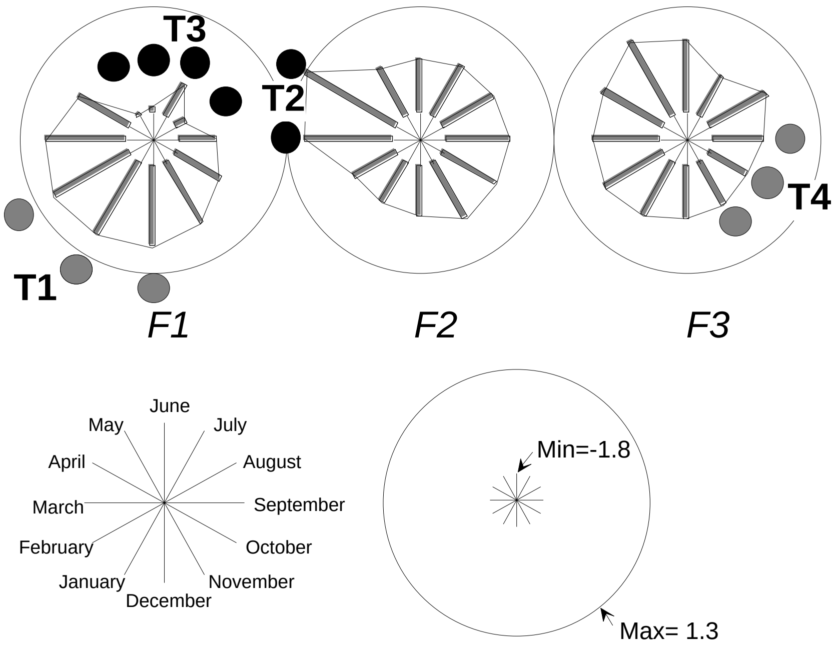
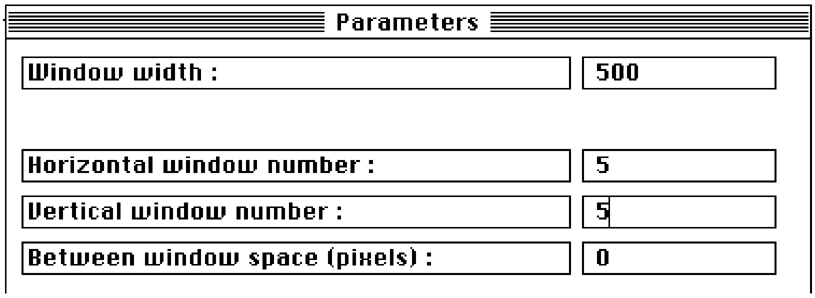
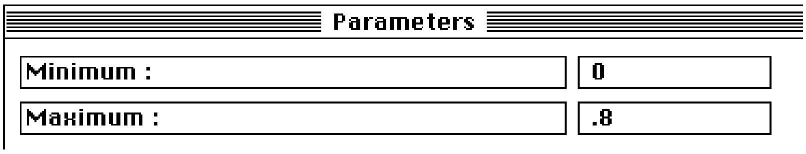


Figure 6 Circle diagram of the three first axes of the correspondence analysis (column scores).





This results in Fig. 5 that depicts the percentage of recaptures per month for each site (1 to 14).

Drawing the values of the factorial scores with the same module gives a synthethic wiew of the spatial and temporal patterns of teals distribution and migrations (Fig. 6).

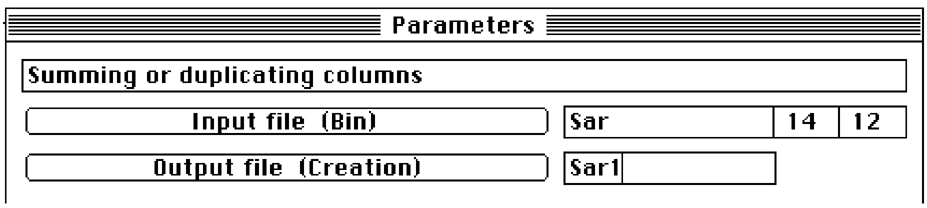
The first axis defines two periods: July-September, May-June, and November-March which correspond to two zones (1 to 6 and 10 to 14) associated with summering and wintering periods respectively.

The second axis separates the wintering period in two components: a wintering period (December-February in Camargue, western France and Spain) and a spring migration (displacement towards eastern France and Italia in March-April).

The third axis describes the migration towards Switzerland, Germany, Benelux and British Iles in autumn.

7 - Table reorganization (see FilesUtil)

The previous results about the spatial and temporal patterns of teals distribution have shown that it is possible to distinguish four periods and five zones among the teal recaptures. Original raw data can be rewritten according to this partition by summing several rows and several columns. Go to the **ADE•Old** selection card and select the **RowOrganise** Quickbasic program, which allows to sum up or to duplicate row blocks in a file. The program makes a loop whenever you decide to add rows. Fill the dialog boxes as follows to sum up rows:



```
1- Sum a group of rows
2- Duplicate a group of rows
3- Exit
Your choice (1/2/3) 1
```

```
Parameters
Select objects as follows
Samples :                  Result
5                          5
1;5;9                      1  5  9
63a66                      63  64  65  66
21a17                      21  20  19  18  17
12a15;5;22a25              12  13  14  15  5  22  23  24  25
12 to 15;5;25-22           12  13  14  15  5  25  24  23  22
3-;5;-4                    3  2  1  5  1  2  3  4
3;-;2                      3  1  2
3;;2-                      3  0  2  1  (Better to be avoided)
--------------------------------------------------------------

Select a group of rows to be summed
11a14
```

```
1- Sum a group of rows
2- Duplicate a group of rows
3- Exit
Your choice (1/2/3) 1
```

```
Select a group of rows to be summed
8a10
```

```
Select a group of rows to be summed
1;3;4
```

```
Select a group of rows to be summed
2;5;6
```

```
Select a group of rows to be summed
7
```

Information about this computation are given in the following listing:

```
File Sar is binary
Number of rows =  14  Number of columns =  12
Row  1  of Sar1 contains the sum or rows of Sar
from selection 11a14 with  4  rows

Row  2  of Sar1 contains the sum or rows of Sar
from selection 8a10 with  3  rows

Row  3  of Sar1 contains the sum or rows of Sar
from selection 1;3;4 with  3  rows

Row  4  of Sar1 contains the sum or rows of Sar
from selection 2;5;6 with  3  rows

Row  5  of Sar1 contains the sum or rows of Sar
from selection 7 with  1  rows

File Sar1 is binary
```

```
Number of rows =  5  Number of columns =  12
```

Edit file `Sar1` to verify the result:

```
8  309  192  56   10   1  1  1  4  21   115  22
1  23   56   42   20   9  14   14   13   3  0  1
1  19   53   60   60   89   208  672  169  4  0  0
4  9  70   39   44   27   34   173  302  54   2  0
1  0  3  2  0  7  5  1  0  1  0  0
```

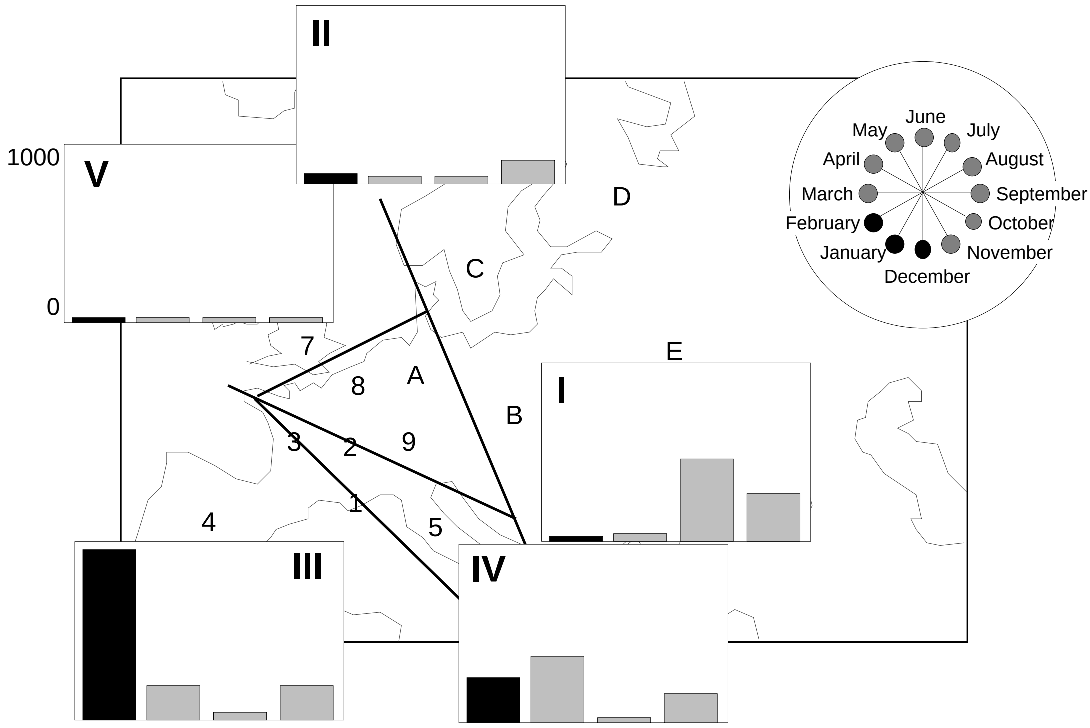
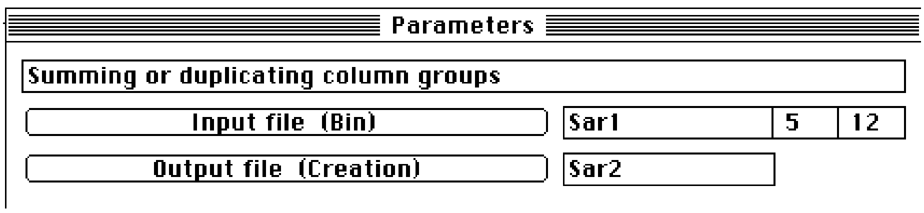


Figure 7 Synthetic diagrams of teal recapture. Histograms use the values resulting from the rearrangement of raw data.

Run the **ColOrganise** Quickbasic program to sum up columns:




```
File Sar1 is binary
Number of rows =  5  Number of columns =  12

Column  1  of Sar2 contains the sum or Columns of Sar1
from selection 6a8 with  3  Columns


Column  2  of Sar2 contains the sum or Columns of Sar1
from selection 9a10 with  2  Columns


Column  3  of Sar2 contains the sum or Columns of Sar1
from selection 1a2;11a12 with  4  Columns
```

```
Column  4  of Sar2 contains the sum or Columns of Sar1
from selection 3a5 with  3  Columns

File Sar2 is binary
Number of rows =  5  Number of columns =  4
```

File `Sar2` contains the followings values:

```
3 25   454  258
37   16   25   118
969  173  20   173
234  356  15   153
13   1  1  5
```

Finally, recapture count data (Table 1) can be summarized by Fig. 7.

Références

[1] Hoffmann, L. (1960) Untersuchungen an Enten in der Camargue. *Ornithologische Beobatcher* : 57, 35-50.

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[4] Hirschfeld, H.O. (1935) A connection between correlation and contingency. Proceedings of the Cambridge Philosophical Society, Mathematical and Physical Sciences : 31, 520-524.

[5] Hill, M.O. (1974) Correspondence analysis : A neglected multivariate method. Journal of the Royal Statistical Society, C : 23, 340-354.

[6] Greenacre, M.J. & Vrba, E.S. (1984) Graphical display and interpretation of antelope census data in African wildlife areas, using correspondence analysis. Ecology : 65, 984-997.

[7] Thioulouse, J. & Chessel, D. (1992) A method for reciprocal scaling of species tolerance and sample diversity. Ecology : 73, 670-680.

[8] Hill, M.O. (1973) Reciprocal averaging : an eigenvector method of ordination. Journal of Ecology : 61, 237-249.

[9] Williams, E.J. (1952) Use of scores for the analysis of association in contingency tables. Biometrika : 39, 274-289.