A COMPUTING METHOD FOR DISTRIBUTION MAPPING

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SUMMARY: A method is presented which enables mapping distributions of species using a personal computer, with the program dBASE III+, and the mapping program SURFER.

RESUMEN: Se presenta un método que permite construir mapas de distribución de especies utilizando un ordenador personal, con el programa de gestión de datos dBASE III+ y el programa gráfico SURFER.

INTRODUCTION

Of all the tasks which arise in faunistic works, the construction of distribution maps is one of the most tedious, mainly when there are too many species and localities. During our studies on Hymenoptera of the Canary Islands, data were computerized in dBASE III PLUS; at this point, the idea of automatically mapping the data arises. Because of the limitations imposed by the hardware available and the software used in data bases, we have constructed the maps with our own software, which has the following characteristics:

Size in bytes:- A minimal amount of RAM memory is used, so that operating in wedge mode is possible from dBASE.

Input/output capabilities:- Data inputs in standard format, like ASCII code, is allowed. Also, the resulting maps can be printed with either a laser printer or a plotter.

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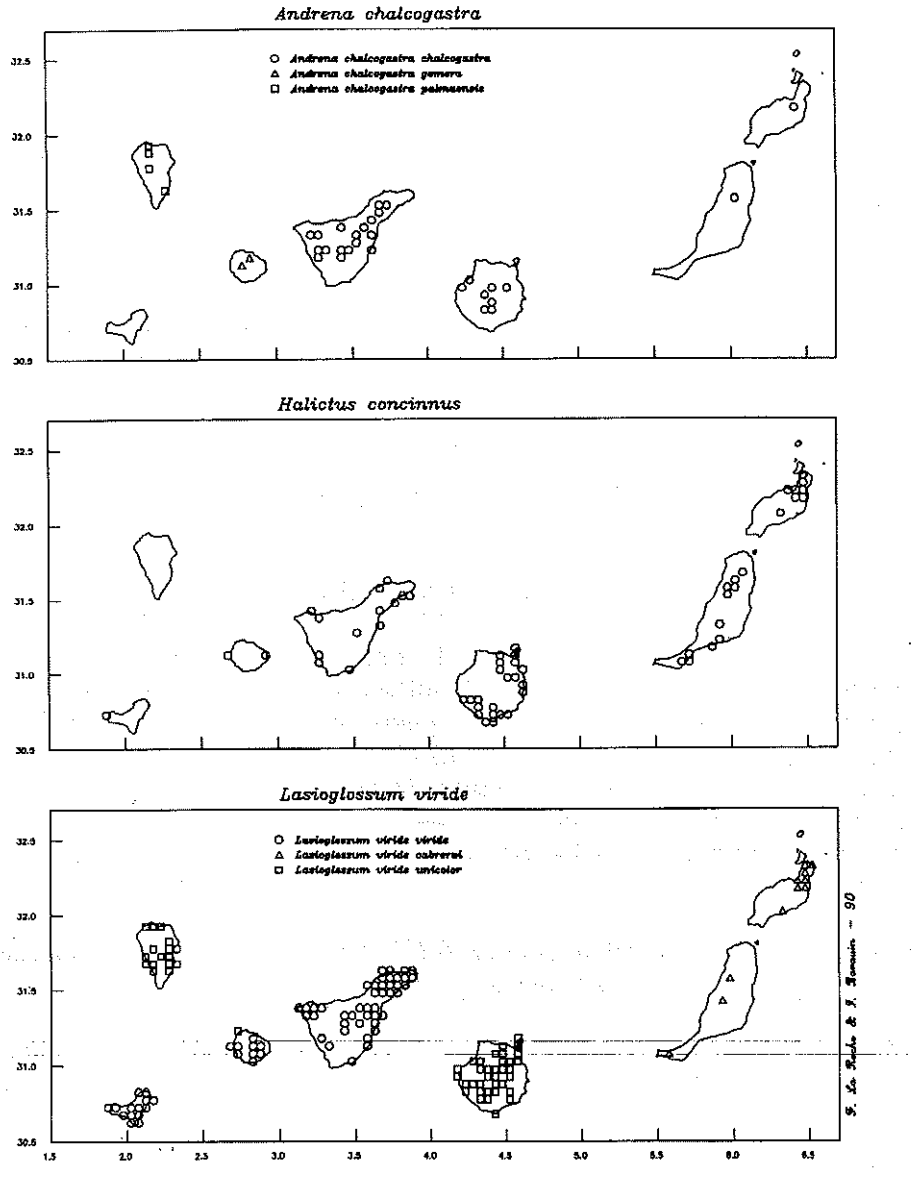


Figure 1. Example of automatic mapping related with a database of Hymenoptera. Top and bottom represent two different species with three subspecies each. Middle: One species with a wide distribution.

Flexibility:- A flexible programming language, so that maps can be build up from the dBASE according to the requirements of each case.

Among the wide variety of software available for PC's there are several which fulfil the requirements. We have chosen SURFER. The stages for building up the method were three:

A) CARTOGRAPHIC DIGITALIZATION

1) Separate digitization of features of the maps, such as contour lines, roads, city names and other geographical features of interest, means that each map can contain any combination.

2) The best current maps of the Canary Islands are in UTM coordinates, and records of the different biogeographical features are associated with these coordinates; the outlines of the map have to be introduced in this way. We have used a graphics tablet to reproduce the maps of the islands. The software was created so that whichever position you place the map, the points obtained will be in the same coordinates. This will also be accurate if other scales are used. This has become possible since we wrote a program that automatically makes an algebraic transformation to compute the points in UTM coordinates.

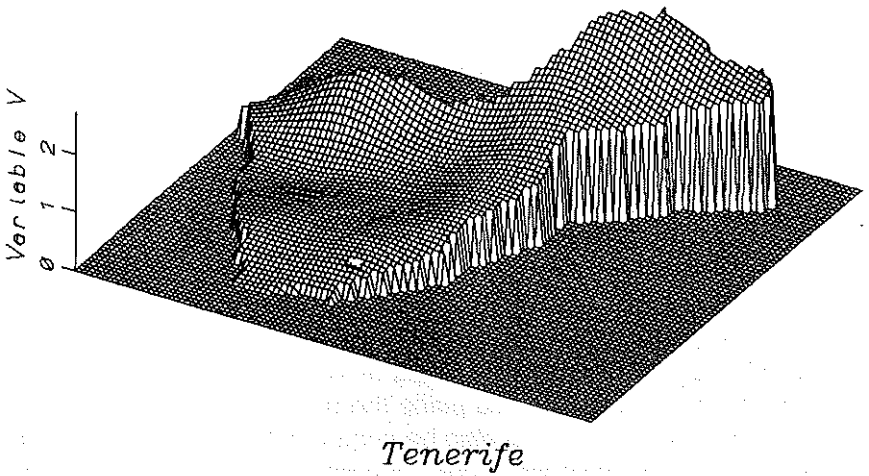
In this way we have made a map of each of the seven Canary Islands, placing contour lines and other geographical features. These maps, either in whole or in part and with the different grids, labels and references are the point of departure upon which the other biogeographical information will be superimposed. We also created the software necessary for calculate perimeter, surface and average altitude of each square.

B) BUILDING UP THE DATABASE OF BIOGEOGRAPHICAL RECORDS

1) The main file has to contain, at least, the following fields (Table 1):

- Fields 1 and 2 contain the coordinates UTM and absolute coordinates x and y, respectively, of the points where the biogeographical records have been taken and are going to be represented.

- Field 3. Contains the code of the event that is desired to be represented. For example "38 3 4 1" and "38 3 4 2", will represent different species of the same genus.



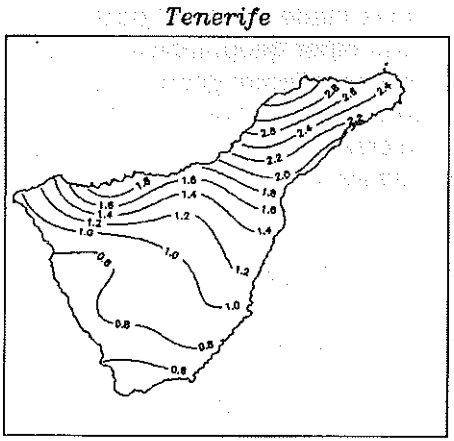


Figure 2. Graphic in two and three dimensions of a density function.

- Field 4. Dates of observation or captures.

- Other fields may contain number of male or females, name of island, locality, associated species or other biogeographical or taxonomic information.

Field Name	Type	Width	Example
UTM	Character	6	BS1372
ABSUTM	Character	10	2.31 31.72
HYCODE	Character	12	38 2 4 2
LOCALI	Character	20	Tazacorte
ISLA	Character	1	P
FECHA	Date	8	14-04-80
PCODE	Character	12	36 3 3 1

Table 1. Example of part of a database

Other files contain the codes that have been used to represent the different species together with complete names of the species. All the files should have some common field so that relations can be done between them.

C) SUPERIMPOSITION OF BIOGEOGRAPHICAL INFORMATION ON THE MAPS

Using a graphic representation program in conjunction with the database, data are filtered through user-defined conditions and then exported in ASCII code. Depending on desired representation, the map can then employ a variety of symbols, numbers and labels, all of which may be of a pre-determined size. (Figure 1). A variety of different programs permit choice, automatic filters and fixed symbols may be represented, or for each map different symbols may be chosen.

We chose to write programs in dBASE which can both recover the data and adapt the maps to the required conditions. The programs in dBASE build up the sentences with which Surfer operates, without going out of the main program. The information required for the programs (for example, the initial of the island) is used for two purposes: selecting the data from dBASE and selecting the required map. In the same way, the title of the map is transferred automatically to SURFER's program. This superimposition can be a mathematical operation with these variables. The result of this mathematical combination can then be represented on the map.

As you would expect, the use of biological data as a starting point is purely conventional. It is possible to represent any data if they fulfil some minimal conditions. Maps can be built up with climatic, edafological, or demographic information, or flora and fauna distributions, etc. Figure 2 represents a hypothetical variable, in two and three dimensions.

Finally we intend - with the help by botanists, zoologists, geographers, etc.- to integrate all of this data for the Canaries; mainly to obtain distribution and evolution patterns, and study the relationships between animals and/or plants and their environment, using advanced methods and computers.

REFERENCES

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TSU-DER CHOU, & W. EDWARD TILEY:
1989. *dBASE IV Handbook.* 3rd Edition. Que Co., Carmel, IN.

NOTE: dBASE (Ashton-Tate Corporation) and SURFER (Golden Software Inc.) are trademarks.