KARST WATERS INSTITUTE

LABORATOIRE SOUTERRAIN

Special Publication 6

Mapping Subterranean Biodiversity
Cartographie de la biodiversité souterraine

Proceedings of an international workshop held
March 18 through 20, 2001
Laboratoire Souterrain du CNRS, Moulis, Ariege, France

Edited by
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Geo-referenced computer recordings as an instrument for protecting cave-dwelling species of Tenerife (Canary Islands)

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When conservation decisions have to be taken on which caves to protect, and we do not have sufficient resources for all of them, then we need criteria that will help us to establish priorities, in order to be able to protect the largest number of species in the least number of sites. The first candidate for protection is the site with the most species, but the second choice would not be the next richest in species, but the one with the largest number of different species from those found at the first site. It is important to have geo-referenced computer records to help in this decision-making process, such as those included in the ***Atlantis software***. This software has made it possible to simulate the conservation priorities of Tenerife's volcanic cavities, as is explained in this paper.

The geographical information on 14,000 species and subspecies of Canary islands is now computerised in a data base thanks to the setting up of the 'Biota–Canarias' project initiated by the Government of the Canary Islands in 1998. To carry out the project *Atlantis* software is used to organize the alphanumeric and geographic data on the species in the Canaries, at a minimum scale of 500 x 500 metres. The data are stored according to different levels of precision and confidence, depending on the source information. This *Atlantis* software includes an analysis module that enables calculations to be made on different ways of measuring biodiversity. Thanks to this module we have been able to carry out a simulation of conservation priorities for the underground environment of the island of Tenerife.

A total of 59 exclusively hypogean species have been described in Tenerife, of which 56 are endemic to the islands (Medina 1991, Martín 1992, Oromí *et al.* 2000). They are basically distributed along the entire southern strip of Tenerife and have been found both in volcanic compartments and in underground habitats near the surface. According to information taken from the Biodiversity Data Base of the Canary Islands, of the 8.500 cells of 500 x 500 metres spread over the surface of the island of Tenerife, troglobites are present in 335.

When we consider establishing the protection or conservation of the volcanic cavities or the underground environment in general, we should bear in mind how the species living in it are distributed. One of the most common estimates to calculate biodiversity is the "richness of species". When an analysis is made of the richness of troglobites on the island of Tenerife at a scale of 500 x 500 m, the result is a series of relatively high scores, coinciding with the location of the underground complex of Viento, Sobrado and Felipe Reventón caves (Fig. 1).

Nine cells each contain 20 or more species. Another four, more dispersed, show up scores of between 10 and 20 species. The remaining cells hold fewer than 10 species. An initial conservation proposal would involve making a priority selection of the 9 'richest' cells, followed by the four that have intermediate scores for richness of species. Together, the 13 cells account for 46 species, *i.e.*, 78% of the total number of troglobites in Tenerife.

Another way of measuring biodiversity is based on the "rarity of species" by Rapoport *et al.* (1986). This consists of establishing which cells hold the largest number of species that have low representation in the total of cells studied. With the exception of one cell, the coincidence with the cells from the richness analysis is total. Together, the 10 cells account for 48 species, *i.e.*, 81% of the total number of troglobites in Tenerife.

The rarity of species can also be expressed to the full extent when those cells that contain exclusive species are selected. In this way "extreme rarity" can be calculated, through which irreplaceable cells can be obtained (Pressey *et al.* 1994), in such a way that the destruction of one of them involves the disappearance of some species of their unique localities. In Tenerife there are 6 irreplaceable cells in the analysis of troglobites, two of them containing 2 species and the others one. In this case, the coincidence in cell distribution in relation to the richness analysis is slight; 3 new cells appear and none of the 9 cells with a higher number of species is represented. Together, the 6 cells account for 38 species, *i.e*,. 64 % of the total number of troglobites in Tenerife.
As mentioned in the previous point, the choice of the most important areas in which to establish conservation should be based on high biodiversity values. Once the richest cell has been located, we should consider the next cell where conservation efforts are to be made, then the third most important, and so on until the largest number of species in the smallest number of locations or cells is obtained. Therefore, if the aim is to achieve the best possible use of the resources allocated to the conservation of biodiversity, we should focus priorities on the protection of the group of cells that contain the greatest representation of all the species. This objective can be achieved by applying the "principle of complementarity", whereby the process of cell selection should favour those with the largest number of species that have not been previously selected (Vane-Wright *et al.* 1994).

Through the automatic analysis of conservation priorities provided by the *Atlantis* software, a set of 13 cells of high distribution on Tenerife appears. This set has two major characteristics: 1) within the 13 cells, which account for 0.15% of the territory of the island, all the underground biodiversity of the island is represented, and 2) the analysis includes the order of priority whereby conservation efforts on the underground environment of the island should be established. A comparison of the result of the complementarity analysis with that obtained in the calculation of richness shows that the first one selects 8 cells not included in the richness scale. Moreover, of the 9 priority cells (given priority as a result of their richness of species) only 2 are selected in the complementarity analysis .
The cell selected in first place is the 500 x 500 m square with the largest number of species (33), located in the Cueva del Viento area. The next one has far fewer species (13) but contributes 5 new ones to the set. The next cell, despite containing more species than the previous one (16), only contributes four new species. The process continues until a cell is reached that does not contribute any new species. By this point the totality of the cave fauna species on the island of Tenerife have been covered. Within this selection process, at the same time as new species are incorporated, a process of repetition or "redundancy" of species is introduced. This process is important when it comes to selecting between two or more cells containing the same number of new species (Fig. 2). The option in this case would be making the selection in favour of the higher redundancy value, because we would thus give priority to the conservation of a larger number of populations of already protected species.

However, even in the selection process for complementarity the number of new species could be the same, and exactly the same could occur with the number of redundant species, so it would be necessary to support decisions on priority by applying other analyses to this limited group of cells. In this specific case we have used the calculation of the rarity and the calculation of "taxic diversity" by Vane-Wright *et al.*, 1994. The results of the calculation or rarity are as follows: cell 6 (0.053), 8 (2.342), 12 (1.025) and 13 (1.076) (see presentation). For the calculation of taxic diversity, the values of the number of families and genus in cells are: in cell 6 (3,4 respectively), incell 8 (4,4), 12 (2,3) and 13 (3,3). In this manner, through the calculation of both rarity and taxic diversity, an order of priority is obtained, *i.e.*, 8-6 and 13-12.

Therefore, taking into account the principle of complementarity, progressive mean redundancy, local rarity and taxic diversity, a set of 13 priority cells is obtained for the conservation of the underground environment on the island of Tenerife, with an order of priority as follows (Fig. 3).

References

Medina, A. L. 1991. *El estudio subterráneo superficial en las Islas Canarias: caracterización y consideraciones sobre su fauna.* Tesis doctoral (sin publicar). Universidad de La Laguna, Tenerife.

Martín, J.L. 1992. *Caracterización ecológica y evolución de las comunidades subterráneas en las islas de Tenerife, El Hierro y La Palma.* Tesis Doctoral (sin publicar) . Universidad de La Laguna. 342 pp.

Oromí, P., E. Muñoz, N. Zurita & S. de la Cruz. 2000. *Conservación de la fauna invertebrada cavernícola de las islas de Tenerife, La Palma y El Hierro.* 3er informe. Dto. De Biología Animal-Universidad de La Laguna. 248 pp.

Pressey, R. L., I.R. Johnson & P.D. Wilson. 1994. Shades of irreplaceability: measuring the potential contribution of sites to a reservation goal. *Biodiversity and Conservation* 3:242-262.

Vane-Wright, R.I., C.J. Humphries & P.H. Williams. 1994. What to protect?-Systematics and the agony of choice. *Biological Conservation* 55:235-254.

Rapoport, E.H., G. Borioli, J.A. Monjeau, J.E. Puntieri & R.D. Oviedo. 1986. The design of nature reserves: a simulation trial for assesing specific conservation value. *Biological Conservation* 37:269-290.

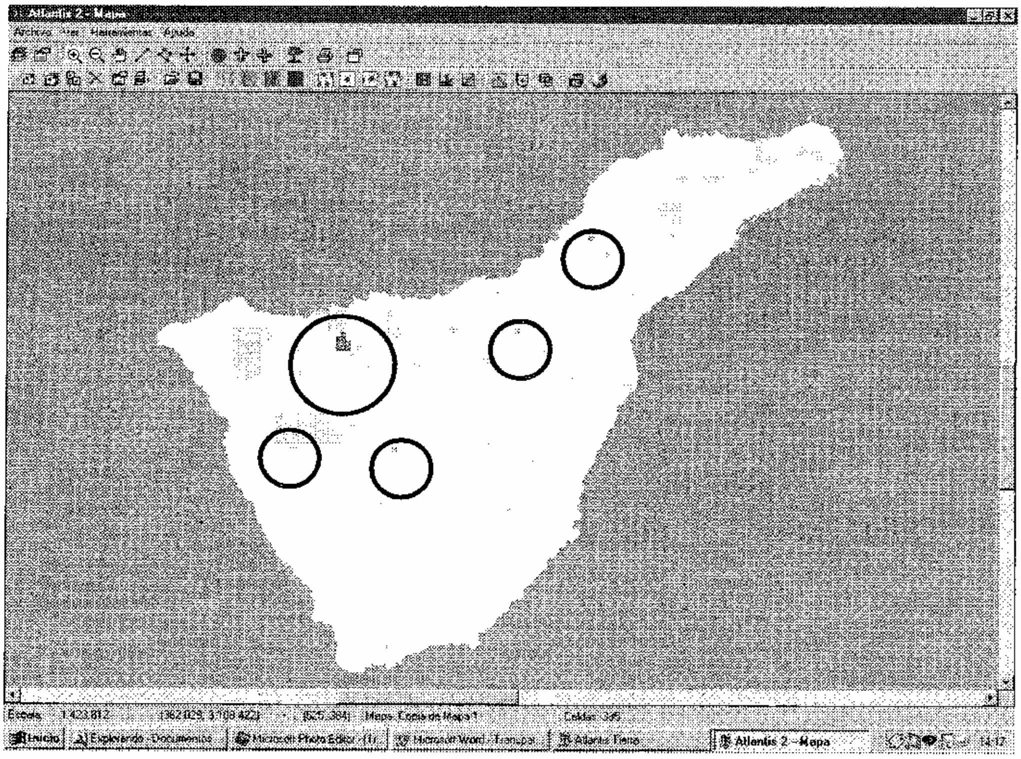

Fig. 1. Map of Tenerife with the most important sites of species richness.

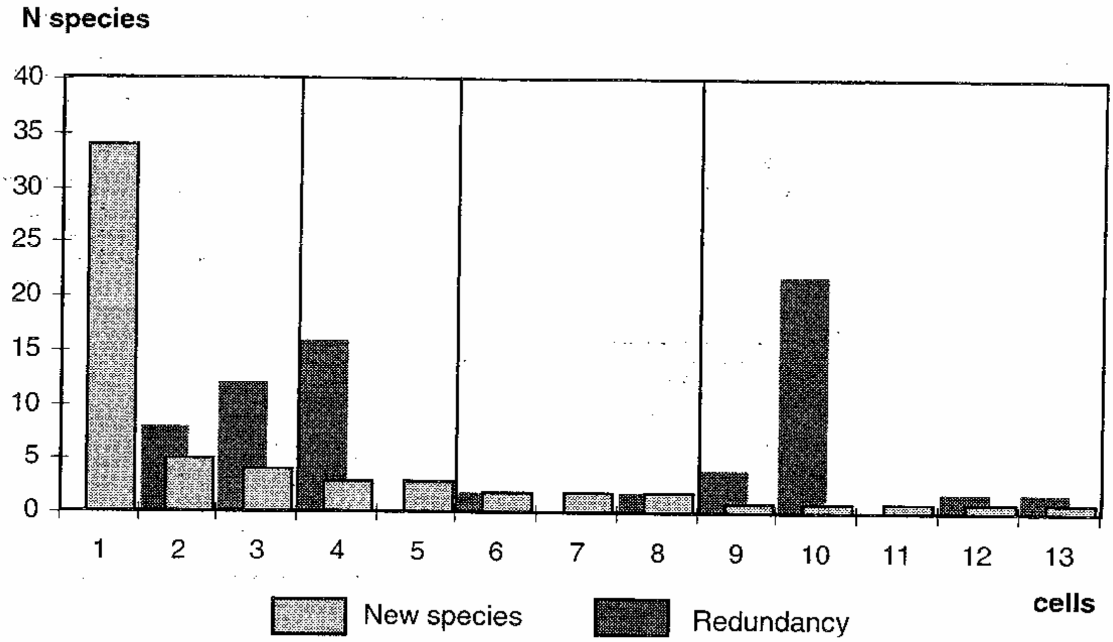

Fig. 2. Selected cells by the complementary priority-cells analysis. The light bars show the number of different species (new species) respect to last selected cell or group of cells. Dark bars show the number of redundant species.

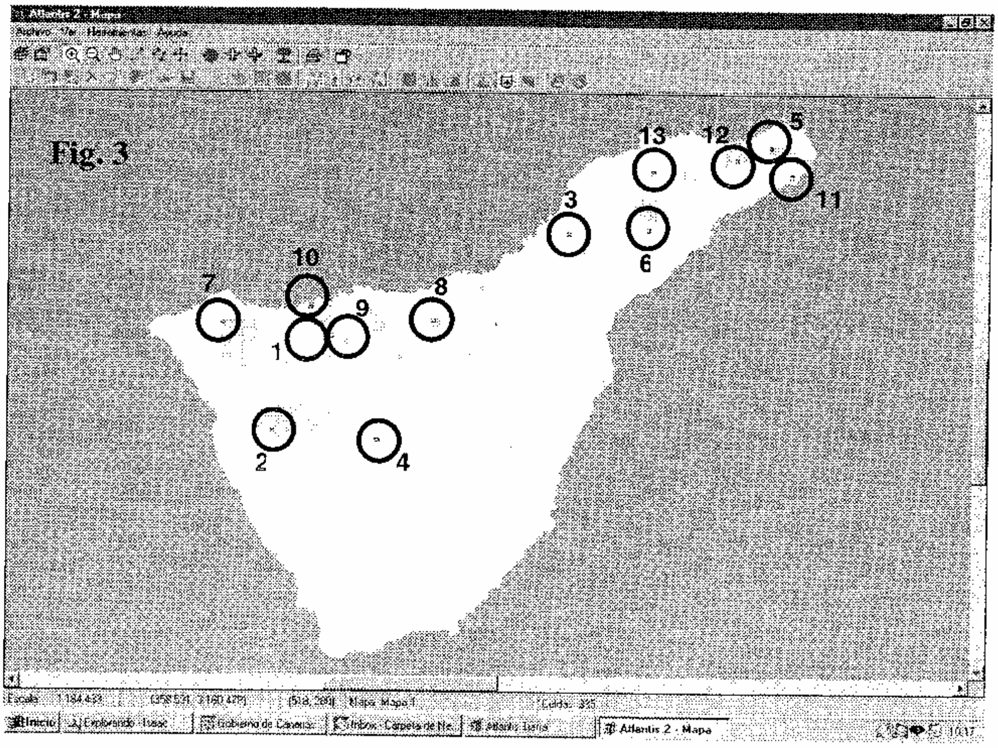

Fig. 3. Map of Tenerife with the conservation priority cells. The numbers show the priority order.