

## **Use of ATLANTIS TIERRA 2.0 in mapping and managing the arthropod biodiversity in the Azorean archipelago**

Paulo A.V. Borges<sup>1</sup> & Enésima P. Mendonça<sup>1</sup>

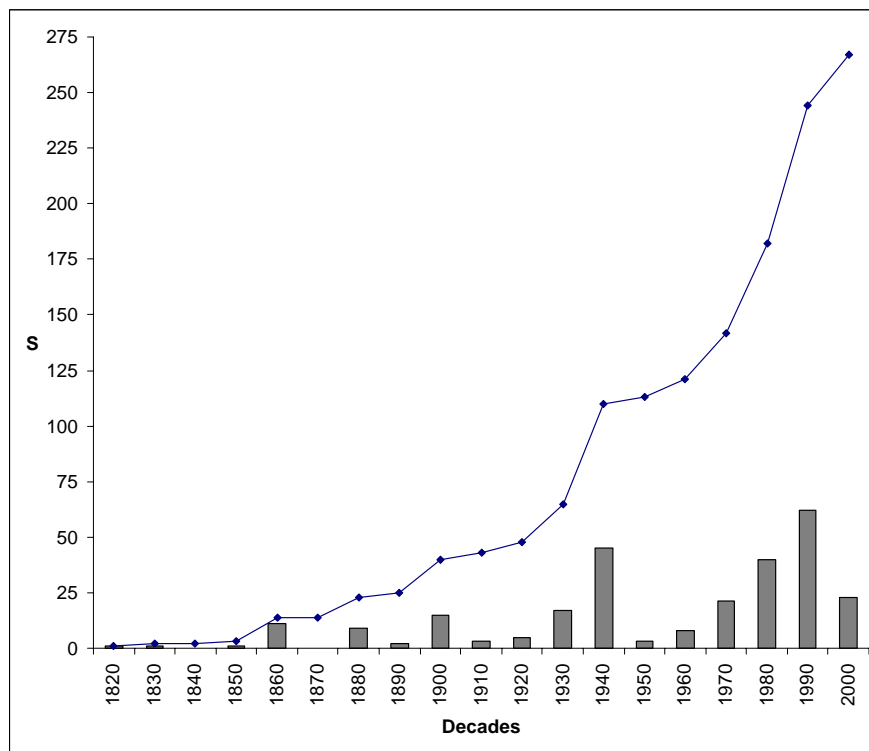
<sup>1</sup>Universidade dos Açores, Dep. Ciências Agrárias, CITA-A, 9700-851 Angra do Heroísmo, Terceira, Açores; Email: pborges@mail.angra.uac.pt.

**Abstract:** In this contribution the software ATLANTIS Tierra 2.0 is described as a promising tool to be used in the conservation management of the arthropod biodiversity of native and man-made habitats of the Azores. ATLANTIS Tierra 2.0 allows the mapping of the distribution of all species in a 500 x 500 m grid in a GIS interface. This allows an easy detection of species rich sites (hotspots) and facilitates the interpretation of spatial patterns of species distribution. For instance, predictive models of species distribution could be constructed using the distribution of habitats and environmental variables. Using this new tool we will be better equipped to answer the following questions: a) Where are the current “hotspots” of biodiversity in the Azores?; b) How many new sites need to be selected as specially protected areas in order to conserve the rarest endemic taxa?; c) Is there congruence between the patterns of richness and distribution of invertebrates and other taxa?; d) Are environmental variables good surrogates of species distributions?

**Key Words:** Biodiversity, Arthropods, Azores, ATLANTIS database, conservation management

## 1. INTRODUCTION

The richness of Azorean arthropod fauna is particularly high when compared with other groups of organisms (see Borges et al., 2005a). The cumulative discovery curve for the endemic species of arthropods presented in Figure 1 illustrates the considerable time taken to acquire this knowledge, as measured by the number of published descriptions of endemic species. By 1950 only 41% of the listed species had been recorded; and in 1979 only 53% of the species had been described. To reach 90%, the descriptions published between 1990 and 1999 need to be included (Figure 1). Although some recent effort to list all the terrestrial flora and fauna of the archipelago (see the catalogue in Borges et al., 2005b), knowledge of many groups of invertebrates is still unsatisfactory, especially with regard to de micro-fauna.



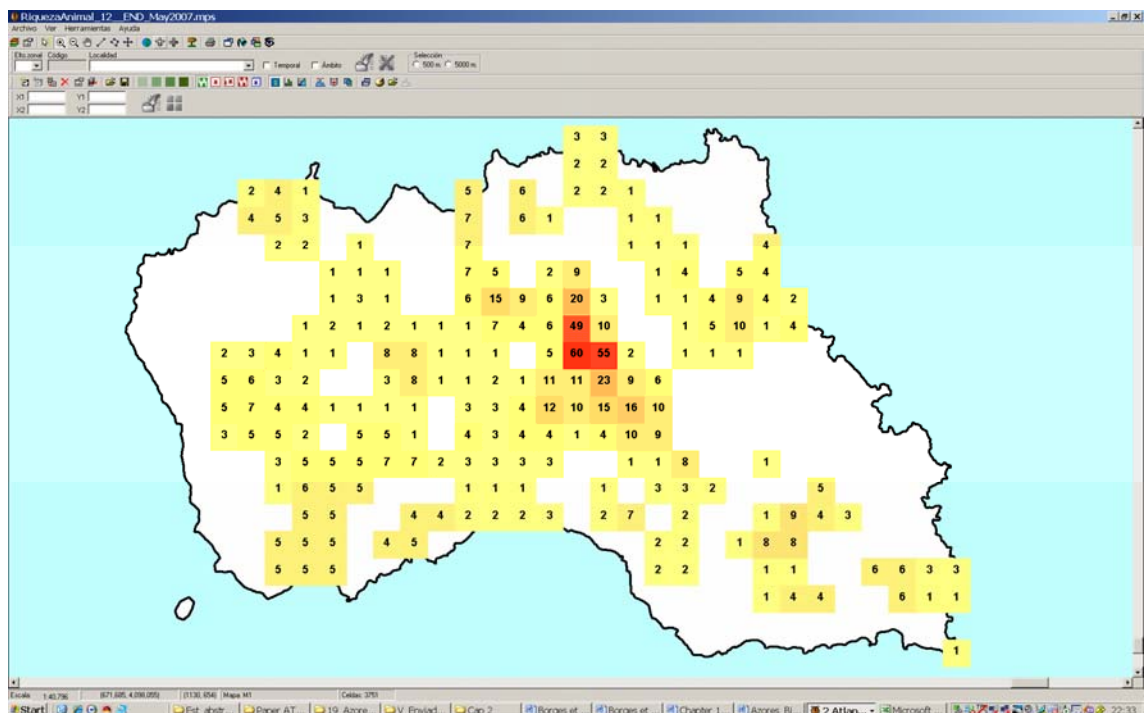
**Figure 1. Cumulative endemic species discovery curve for arthropods (only Azorean endemics) known in the Azorean archipelago. Data points are plotted cumulatively by decade and represent the number of species (S) added to fauna based upon date of scientific description (adapted from Borges et al., 2005a).**



The use of this database for the management of Azorean biodiversity started only in 2004 under the INTERREGIIB Project ATLÂNTICO (see Borges, 2005) and currently is already storing about 490 000 records for the distribution of Azorean arthropods. The main aims of this database are the following (see also Borges, 2005):

- 1) Know the distribution of Azorean biodiversity (see Figure 3);
- 2) Inform about the current “hotspots” of biodiversity (see Figure 3);
- 3) Allow the modelling of the distribution of species;
- 4) Inform about new sites that will need to be selected as specially protected areas in order to conserve the rarest endemic species;
- 5) Investigate the congruence between the patterns of richness and distribution of different groups of species;
- 6) Help the conservation management of biodiversity.

Several important tools are available such as the calculation of species richness (see Figure 3), their rarity or complementarity in all 500x500 m cells of a particular island or, in any special area in one island.



**Fig. 3. Clines of terrestrial endemic arthropod and mollusc species richness reported to Santa Maria island. Red 500x500 m cells are the hotspots in species**

richness and occur in Pico Alto (data from ATLANTIS Tierra database, see Borges et al., 2005).

However, it is in the data analysis facility that ATLANTIS Tierra 2.0 is more interesting since there are several tools adequate for helping in the selection of areas of interest for conservation. The most promising one is the “Complementarity” procedure in which we may ask “how many 500x500m are needed to include all species of interest at least once?”. ATLANTIS Tierra 2.0 uses the heuristic suboptimal simple-greedy reserve-selection algorithm (see also Williams, 2001; Borges et al., 2005c): first, the grid-cell with the highest species richness is selected; after, these species are ignored and the grid-cell with the highest complement of species (that is, the most species not represented in the previous selected grid-cell), and so on, until all species are represented at least once. An example of the application of the complementarity procedure is showed in Figure 4, in which there is the need of ten 500x500 m grid cells to protect the 19 endemic beetle (Insecta, Coleoptera) species occurring in Terceira island.

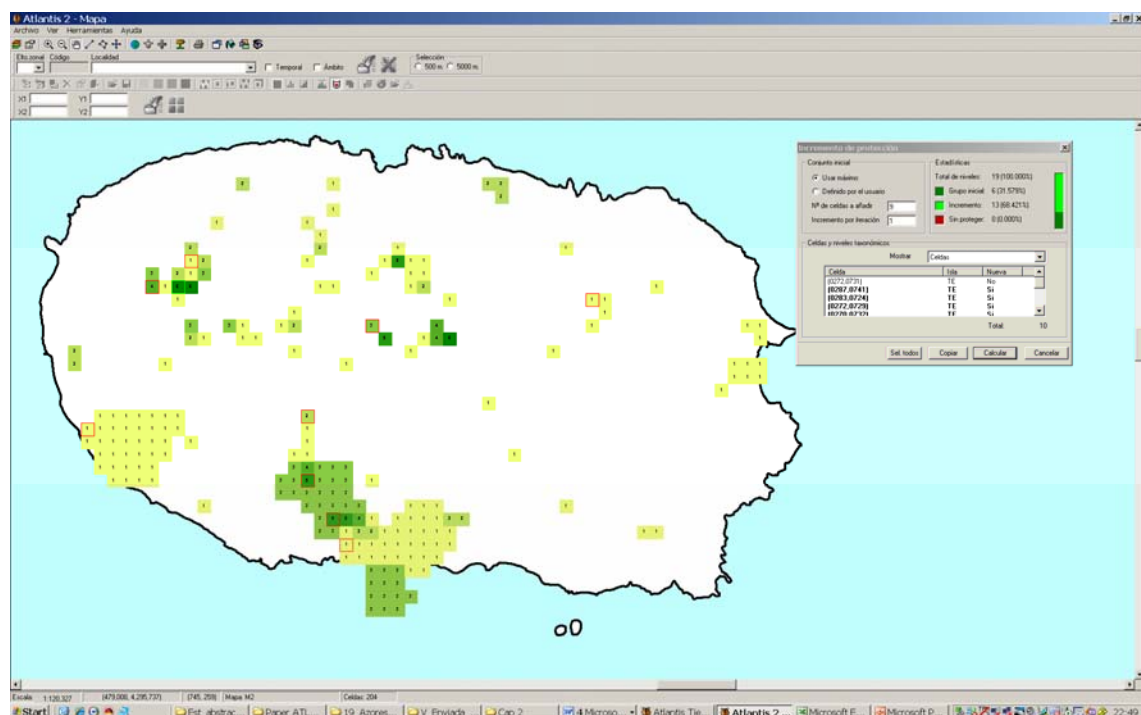


Figure 4. Data analysis window of ATLANTIS Tierra 2.0, in which it is possible to observe marked in red the grid-cells that are necessary to include all the endemic beetles (Insecta, Coleoptera) occurring in Terceira island (see text for further explanations).

Those ten grid-cells are signalized with a green dark border (the first selected grid-cell with six species) and with a reddish dark border (the nine other selected grid-cells). Therefore, with only ten well managed sites we may protect all the endemic beetles species known to occur at Terceira Island (Azores). However, we should call attention to the fact that the complementarity procedure could be made more complex asking for the minimum set of sites that combined have at least each species represented twice, therefore assuring that species are protected in more than one place.

### **3. CONCLUSION**

The use of biodiversity databases is currently of great importance in conservation management. Good examples are the Fauna Europaea Project database (see <http://www.faunaeur.org>) and the GBIF ([www.gbif.org](http://www.gbif.org)). Arthropods, as a megadiverse group, have always presented a difficult challenge for taxonomists, ecologists and conservationists. Using ATLANTIS Tierra 2.0 we will be better equipped to answer the following questions: a) Where are the current “hotspots” of biodiversity in the Azores?; b) How many new sites need to be selected as specially protected areas in order to conserve the rarest endemic taxa?; c) Is there congruence between the patterns of richness and distribution of invertebrates and other taxa?; d) Are environmental variables good surrogates of species distributions?

With this new tool we hope to promote the inventory of species and modelling species distribution in Azorean habitats, contributing for the regional nature conservation management.

- a. Promote the inventory of species of poorly known taxonomic groups (e.g. cave fauna; parasitic hymenoptera, bryophytes, etc.);
- b. Study the rarity status of Azorean arthropods to produce the first Red Data Book of Azorean arthropods;
- c. Maintaining the management of the Data Base “ATLANTIS” cooperating with other colleagues in Madeira and Canary Islands;
- d. Promote the spread of biodiversity knowledge in the society, creating a web based portal of the Azorean biodiversity in cooperation with Secretaria Regional do Ambiente;

- e. Evaluate the benefits of the new IUCN reserve scheme when compared with the NATURA 2000 scheme for the conservation of endemic and/or rare species;
- f. Use adequate tools for the selection of new areas for the protection of Azorean biodiversity.

#### 4. ACKNOWLEDGEMENTS

Digital information of the islands was obtained within Project ATLÂNTICO – INTERREG IIIB, with permission of “Instituto Geográfico do Exército” under contract nº 047/CCO/2003.

#### 5. REFERENCES

- Borges, P.A.V. (2005). Introduction. In *A list of the terrestrial fauna (Mollusca and Arthropoda) and flora (Bryophyta, Pteridophyta and Spermatophyta) from the Azores* (eds P.A.V. Borges, R. Cunha, R. Gabriel, A.M.F. Martins, L. Silva, & V. Vieira). pp. 11-20, Direcção Regional de Ambiente and Universidade dos Açores, Horta, Angra do Heroísmo and Ponta Delgada.
- Borges, P.A.V., Aguiar, C., Amaral, J., Amorim, I.R., André, G., Arraiol, A., Baz A., Dinis, F., Enghoff, H., Gaspar, C., Ilharco, F., Mahnert, V., Melo, C., Pereira, F., Quartau, J.A., Ribeiro, S., Ribes, J., Serrano, A.R.M., Sousa, A.B., Strassen, R.Z., Vieira, L., Vieira, V., Vitorino, A. and Wunderlich, J. (2005c). Ranking protected areas in the Azores using standardized sampling of soil epigeal arthropods. *Biodiversity and Conservation*, 14: 2029-2060.
- Borges, P.A.V., Cunha, R., Gabriel, R., Martins, A. F., Silva, L., Vieira, V., Dinis, F., Lourenço, P. & Pinto, N. (2005a). Description of the terrestrial Azorean biodiversity. In *A list of the terrestrial fauna (Mollusca and Arthropoda) and flora (Bryophyta, Pteridophyta and Spermatophyta) from the Azores* (eds P.A.V. Borges, R. Cunha, R. Gabriel, A.M.F. Martins, L. Silva, & V. Vieira). pp. 21-68, Direcção Regional de Ambiente and Universidade dos Açores, Horta, Angra do Heroísmo and Ponta Delgada.

- Borges, P.A.V., Lobo, J.M., Azevedo, E. B., Gaspar, C., Melo, C. & Nunes, L.V. (2006). Invasibility and species richness of island endemic arthropods: a general model of endemic vs. exotic species. *Journal of Biogeography* 33: 169-187.
- Borges, P.A.V., Vieira, V., Dinis, F. Jarrora, S., Aguiar, C., Amaral, J., Aarvik, L., Ashmole, P., Ashmole, M., Amorim, I. R., André, G., Argente, M. C., Arraiol, A., Cabrera, A., Diaz, S., Enghoff, H., Gaspar, C., Mendonça, E.P., Gisbert, H. M., Gonçalves, P., Lopes, D.H., Melo, C., Mota, J.A., Oliveira, O., Oromí, P., Pereira, F., Pombo, D.T., Quartau, J. A., Ribeiro, S. P., Rodrigues, A. C., Santos, A. M. C., Serrano, A.R.M., Simões. A.M., Soares, A.O., Sousa, A. B., Vieira, L., Vitorino, A. and Wunderlich, J. (2005b). List of arthropods (Arthropoda). In *A list of the terrestrial fauna (Mollusca and Arthropoda) and flora (Bryophyta, Pteridophyta and Spermatophyta) from the Azores* (eds P.A.V. Borges, R. Cunha, R. Gabriel, A.M.F. Martins, L. Silva, & V. Vieira). pp. 163-221, Direcção Regional de Ambiente and Universidade dos Açores, Horta, Angra do Heroísmo and Ponta Delgada.
- Izquierdo, I., Martin, J.L., Zurita, N. & Arechavaleta, M. (eds.) (2001) *Lista de especies silvestres de Canarias (hongos, plantas y animales terrestres) 2001*. Consejería de Política Territorial y Medio Ambiente del Gobierno de Canarias.
- Lawton, J.H. & May, R.M. (1995) *Extinction Rates*. Oxford University Press, Oxford.
- Silva, L. & Smith, C.W. (2004) A characterization of the non-indigenous flora of the Azores Archipelago. *Biological Invasions*, 6: 193-204.
- Williams P. (2001). Complementarity. In: Levin S. (ed.), *Encyclopaedia of Biodiversity*, Volume 5. Academic Press, pp. 813-829.