**Eva Barreno & Sergio Pérez-Ortega**

# The UNESCO-MAB Reserve of Muniellos (Spain, Asturias), an example of high Lichen diversity in Europe and the success of conservation strategies

**Abstract**

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The aim of this project was to assess the importance of nearly pristine forests in maintaining lichen diversity. We studied exhaustively the biodiversity of lichens in the Natural Reserve of Muniellos (Spain, SW-Asturias), 5542 hectares, an area important for conservation -being included in the UNESCO-MAB reserves network. Besides their ecological value, these thriving elements and their photobionts can be used as bioindicators for Conservation Biology. The survey has been carried out together with vascular-plant phytosociologists and bryologists. Model plots in almost 70 locations enabled us to demonstrate the extraordinary wealth of the lichen flora in these mountains. Saxicolous lichens, on an almost total dominance of siliceous Palaeozoic substrata, were practically unexplored in the Cantabrian Relief of the Iberian Peninsula. The ancient woods constitute critical habitats for maintaining a large number of species threatened by human activities. As "quality" bioindicators, lichens show that there are no nitrophytic habitats in the Reserve. We have identified a total of 502 taxa, 474 being Lichens and 28 lichenicolous Fungi. The best represented genera are *Cladonia* (47), *Lecanora* (24), *Pertusaria* (19), *Rhizocarpon* (18), *Micarea* (12), *Peltigera* (11), *Usnea* (11), *Fuscidea* (9), *Ochrolechia* (9) or *Epigloea* (7). Many species are rare or unknown in Europe, i.e. *Epigloea renitens*, *Gyalideopsis calabrica*, *Cystobacidium hypogymniicola*, *Rhizocarpon caesium*, *Porpidia flavicunda*, etc. Many of these taxa are considered rare or as sensitive to small environmental changes, while they are relatively abundant in Muniellos.

## Introduction

The main aims of this project were to assess the importance of nearly pristine forests in maintaining lichen diversity. We studied exhaustively the biodiversity of lichens in the Integral Natural Reserve of Muniellos (Spain, SW-Asturias) -5542 hectares mostly in the montane bioclimatic belt- an area important for conservation being included in the UNESCO-MAB Reserves network. Besides the ecological value, lichens and their photobionts can be used as bioindicators for Conservation Biology. The survey has been designed together with vascular-plant phytosociologists and bryologists. Model plots in almost 70 locations enabled us to demonstrate the extraordinary wealth of the lichen flora in these moun-

tains. Saxicolous lichens, on an almost total dominance of siliceous Palaeozoic substrata, were practically unexplored in the Cantabrian Relief of the Iberian Peninsula. Ancient woods constitute critical habitats for maintaining a large number of species threatened by human activities. As "quality" bioindicators lichens show that there are no nitrophytic habitats in the Reserve -only 12% of nitrophilous species (Barreno & Pérez-Ortega, 2003). The results seem to confirm the positive effects that ecological continuity of forests has on the conservation of the general biodiversity. In forest systems vascular plants tend to be neither rare nor threatened. However, the same cannot be said for many lichens and some bryophytes. Muniellos is an exception in Atlantic Europe, where forests with such a level of conservation are rare. The Biosphere Reserve of Muniellos has exceptional characteristics that make it suitable as a laboratory for scientific observation and experimentation. This almost pristine environment can help us to better understand ecosystems in this biogeographical region.

**Survey area**

The Biosphere Natural Reserve of Muniellos (Asturias, Spain) is located in the south western Asturias, within the «counties» (*concejos*) of Cangas del Narcea and Ibias (Fig. 1). The first legal measures to protect the mountainside and the woodlands of Muniellos date back to 1964. However, it was not until 1982 that it took on its present status as a National Biological Reserve. In 1988, it was proposed as an Integral Natural Reserve and in 2003 this category of conservation has been approved by law. The International Council of the MAB program of UNESCO declared it a Biological Reserve in November 2000.

The Muniellos Integral Reserve forms a rectangle oriented in a northwest-southeast direction, covering 5 542 hectares. The altitudes range from 660 m in the surroundings of the river Aviouga near the village of Valdebois to 1 675 m, in La Candanosa peak -Mount Muniellos- which is the highest summit of the surrounding mountain range (Fig. 2). The Reserve displays notable uniformity of geological substrates, with almost total dominance of siliceous Paleozoic substrata (quartzite, sandstones, schists and slates of the Los Cabos series) and, to a lesser extent, the black Ordovician slates. There is an outstanding abundance of quaternary deposits, which basically correspond to areas where the mountain slopes have caved in and which are mostly barren (local name «canchales» or «cheironas»). In the surroundings of Tablizas (main entrance) there is still an alluvial plain.

The climate corresponds mainly to that of the montane bioclimatic belt. The thermometric data recorded at the Tablizas meteorological station are: average annual temperature (T = 10,3 ºC), average maximum temperature in the coldest month (M = 7,7 ºC) and thermal integral (It = 178). The existence of a colline bioclimate is specific to the sunny hilly lowlands of Valdebois and La Viliella. High mountain territories are scarce: they represent the transition from the montane to the subalpine belt: T = 5,5 ºC, m = -6,6 ºC, M = 4,4 ºC, It = 28. Average annual rainfall (P) (1 400 l/m$^2$ > P > 1 700 l/m$^2$) shows that most of the area may be included in the hyperhumid ombroclimate. Only some lower zones, near Valdebois and La Viliella must be considered as humid (P > 1 400 < 1 500 l/m$^2$). Although no data are available concerning the frequent and long-lasting fog and mist, which folk culture claims, this is shown by lichens colonizing tree crowns and rocky outcrops. From a phytogeographical point of view, the Muniellos Reserve must be included in the Eurosiberian Region, Atlantic European Province, Orocantabrian Subprovince, Laciano-Ancarense Sector (Fernández

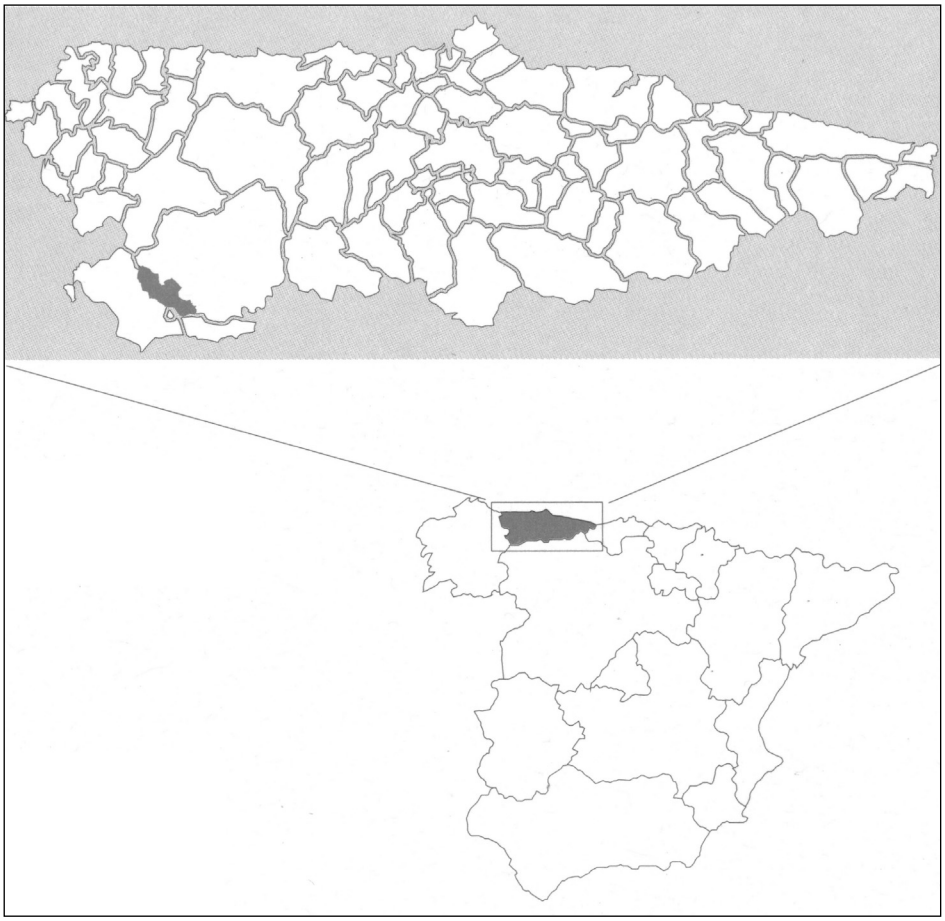

Fig. 1. Geographical location of UNESCO-MAB Reserve of Muniellos (Spain, Asturias).

Prieto & Bueno 1996).

The present Muniellos Natural Integral Reserve constitutes a magnificent representation, almost primogenial in its expanse, of the diversity and state of conservation of a vegetation which, in the past, was dominant in the western regions of the Cordillera Cantábrica (Vàzquez & al. 2002). The importance of Muniellos in the framework of regional and global conservation should be judged taking into account the scarcity of well conserved, mature woodlands throughout Western Europe. In the Atlantic European context, the most frequent potential vegetation must have come from different types of forests with *Quercus robur* and/or *Q. petraea.* However, these woodlands have suffered the highest degree of human exploitation. The high degree of wilderness in Muniellos can be due to multiple factors. Without doubt its inaccessibility, its high rainfall and its abrupt orography, which has, since remote times, prevented forestry exploitation and other modifications of the countryside including those brought about by the imput of nitrogen and phosphorus compounds by human activities.

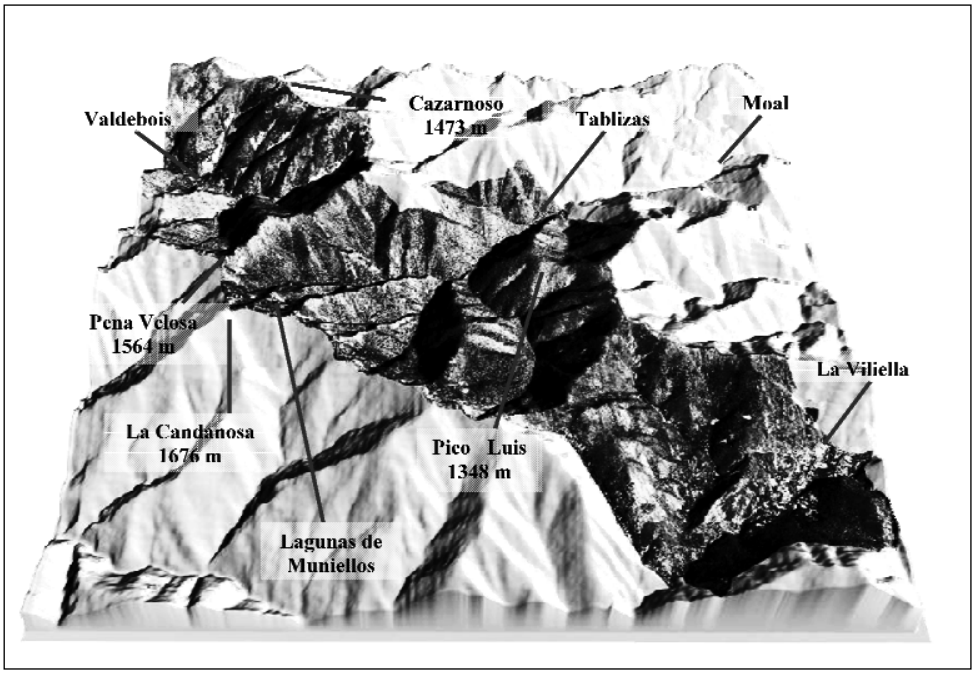


Fig. 2. Map of the Muniellos Integral Natural reserve (Asturias, Spain).

## Material & Methods

The survey has been designed and carried out together with vascular plant phytosociologists and bryologists. The fact that the plots of the woodlands, the serial communities or the edaphically conditioned vegetation have been localized together, to study the different ecosystems, has enabled us to demonstrate the extraordinary wealth of the lichen flora. The methodology was the most commonly used in Lichen taxonomy, including TLC, EEM and SEM. Lichen nomenclature is according to Nimis & Martellos (2004). The programme EstimateS 6.1 (Collwell 1997; Collwell & Codington 1994) was used to calculate the species accumulation curves and the estimators of lichen taxa diversity after 100 randomizations (Collwell 1997; Pérez-Ortega 2004). This estimator of biodiversity is the best accepted in the current literature on Conservation Biology (Colwell & Coddington 1994; Saetersdal & al. 2004)

## Results and Discussion

**1**. A total of 503 taxa were identified, 475 being Lichens and 28 lichenicolous Fungi, which have being included in VAL-Lich Herbarium (4185 nr.). The best represented genera, on the different substrata (Fig. 3), are *Cladonia* (48), *Lecanora* (24), *Pertusaria* (19), *Rhizocarpon* (18), *Micarea* (12), *Peltigera* (11), *Usnea* (11), *Fuscidea* (9), *Ochrolechia* (9) or *Epigloea* (7). 724 specimens of the genera: *Cladonia*, *Lecanora*, *Lepraria*, *Porpidia*,

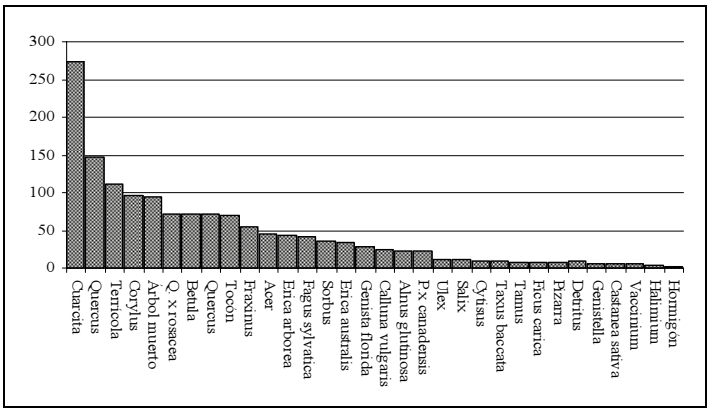


Fig. 3. Number of Lichen species by each type of substrate in Muniellos. (axe y: nr. of species; axe x: types of substrata).

*Usnea* and *Melanelia* were analysed by (TLC). A new chemotype of *Usnea filipendula* containing squamatic acid was detected.

**2.** Many species are «rare» or unknown in Europe, i.e. *Epigloea renitens*, *Gyalideopsis calabrica*, *Cystobacidium hypogymniicola*, *Rhizocarpon caesium*, *Rh. sublavatum, Porpidia flavicunda*, etc. Several of these taxa are considered as rare or sensitive to small environmental changes, while they are relatively abundant in Muniellos, or breaking with the criteria of maximum size in the adult non-senescent stage, i.e. *Lobaria amplissima, Peltigera horizontalis*, etc.

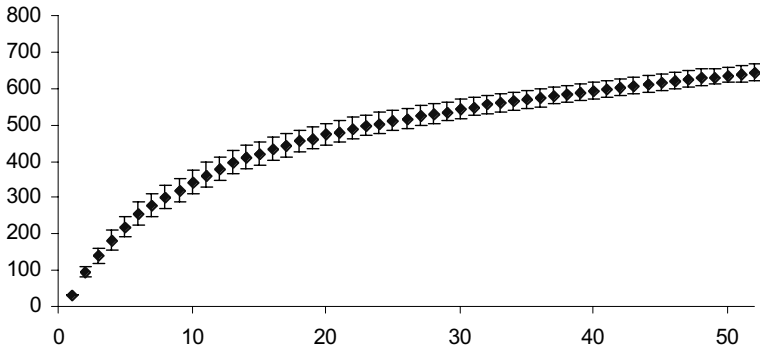


Fig. 4. Species accumulation curve built up after 100 randomizations with the species identified in 59 selected localities from the habitats prospected in Muniellos. The number of the recognized species (502) is close to the asymptote from the Jacknife of first order (640).. (axe y: nr. of species; axe x: nr. of selected localities).

**3**. The genus *Epigloea* is a novelty to the Iberian lichen flora represented by 7 of the 11 recognized species in the world. *Epigloea renitens* was not known from South Europe.

**4**. 48 "Rare" species or new taxa to be added in the Spanish /Iberian lichen flora:, i.e. *Cladonia borealis, C. homosekikaica, C. umbricola, Fuscidea austera, F. gothoburgensis, F. intercincta, Japewia subaurifera, Lecanora aitema, Lecidea brachyspora, Lepraria elobata, L. jackii, Miriquidica deusta, M. nigroleprosa, Placynthiella dasaea, Porpidia contraponenda, P .flavicunda, Ptychographa xylographoides, Racodium rupestre, Rhizocarpon anaperum, Ropalospora viridis, Schaereria pissodes, Tephromela pertusarioides, Trapelia obtegens, Usnea esperantiana, Xylographa abietina*.

**5.** The data obtained from the estimators of biodiversity are: Chao I: 678 species; Jacknife of first order 644 species; Jacknife of second order: 743 species and Bootstrap 551 species. Thus, the lichen flora of the UNESCO-MAB Reserve of Muniellos may be estimated at a total of 640 taxa (Fig. 4).

**6.** Most of the lichens have, at present, a greatly restricted local distribution. More than 36% of the total appears in only one plot, 15 % only in 2 plots, 12 % only in 3 plots, diminishing in a clear negative exponential. "Rare" or "Very rare" lichen species are found in several habitats of the Muniellos Reserve, i.e. **A.** Taxa which can be included in the Red Lists of the IUCN. **B.** Taxa associated with «the ecological continuity of the forests» or with a suitable presence «age class structure» of specimens of ancient trees (Saetersdal & al. 2004). **C.** Taxa in habitats that can be related to the advances and retreats of the flora and vegetation during the paleoclimatic events at the end of the Phanerozoic, probably with the *nunataks* and other Cenozoic periglacial environments. They tend to be relicts and may be related, in many cases, with paleohistoric events.

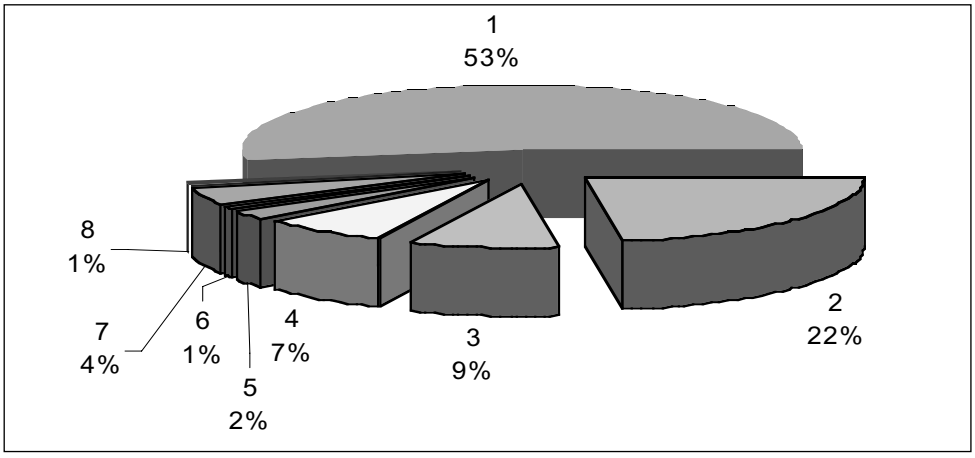


Fig. 5. Distribution of affinities to eutrophicated habitats in the Muniellos lichen Flora: **1.** Species in poor bark - low cc. Mg+, Ca++, K+, Na+, also with acidophyte pH, i.e. *Betula*, *Picea*, *Abies*; **2.** Between types 1 and 3; **3.** Lichens on rich bark, but without eutrophication; **4.** Between types 3 and 5; **5.** Bark rich in nutrients, i.e.: *Acer, Juglans, Sambucus*; **6.** Between 5 and 7; **7.** Lichens on bark rich in nutrients, often besides of dust and/or artificial fertilizers in the environment, **8.** Very eutrophicated environments, with artificial and natural fertilizers and nitrogen atmospheric deposition.

**7.** Only 12% of the catalogue is made up by nitrophytic species (Fig. 5), which are localized in the proximity of two villages as well as in a few ornithocoprophytic habitats . This indicates both the ecological balance found in Muniellos -without accumulations of depositions as direct consequences of human activities- and the excellent state of conservation of these forests.

**8.** A New Book was written including a glossary of nearly 600 voices, 2003. Oviedo. Softbound, 520 pp, 133 colour plates. ISBN 84-96119-36-X.

## Conclusions

A distinctive group of lichen species is associated with the bark of the trunks of old trees. They are not found in any young stands, and are species of the *Lobarion* communities, for which Muniellos is a hotspot of diversity, with numerous species indicating ecological continuity. The use of lichens as bioindicators of environmental conditions and of floristic richness seems to confirm the positive effects of the ecological continuity of forests on the conservation of general biodiversity. In forest systems, vascular plants tend to be neither rare nor threatened. However, the same cannot be said for many lichens and some bryophytes. Something similar could be said about paleoclimatic changes. Some of the lichens in the Catalogue, which at present have a greatly restricted distribution, are found in various habitats of the Muniellos Reserve.

The Biosphere Reserve of Muniellos has exceptional characteristics that make it suitable as an open-air laboratory for scientific observation and experimentation. This almost pristine environment can help us to better understand the peculiar ecosystems of this biogeographical region.

### Acknowledgements

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Address of the authors:
Eva Barreno & Sergio Pérez-Ortega,
Universitat de València. ICBIBE, Dpt. of Botany. Fac. of Biology. C/ Dr. Moliner 50.
46071 Burjassot (Valencia, Spain).