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A multi-taxa approach in mountain ecosystems: a shared protocol between 6 Italian Parks

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Keywords

biodiversity monitoring, multi-taxa approach, elevational gradients

Introduction

Elevational gradients are natural laboratories to study species diversity and community level responses along patterns of environmental variation. Understanding how multiple contrasting taxa respond to elevation along the same gradient, as well as how the same taxa respond to different elevational gradients, is still an important and urgent task in conservation biology. Protected areas play a key role in reducing losses of biological diversity as climate and land-uses change (Kharouba & Kerr 2010). For these reasons, in 2006-2007 Gran Paradiso National Park (GPNP) developed a monitoring scheme to study animal biodiversity in mountain ecosystems along altitudinal gradients and to set the basis for the development of an historical dataset, focused on multi-taxa community data. The protocol will be repeated every 5 years (2 years monitoring - 4 years stop) in order to analyse variation through space and time.
Main objectives are:

- to **measure the biodiversity status**, describing animal biodiversity along altitudinal gradients. This is fundamental for creating a baseline against which to identify future changes and for planning highly focused conservation actions;
- to **forecast the biodiversity status**, for estimating the risk of biodiversity loss, also through the application of environmental change scenarios. This will allow to identify the threshold beyond which the risk of biodiversity loss will be extremely elevated and to identify potential 'vulnerability and safety'.

Led by GPNP, in 2007-2008, the project was extended to two other protected areas in the NW Italian Alps (Orsiera-Rocciavré Natural Park and Veglia Devero Natural Park), representing the first attempt to develop a protocol for long-term monitoring of multiple taxa in the Italian Alps. As planned, in the years 2012-2013, the 3 protected areas carried out the first repetition of the sampling activities. Moreover, in 2013-2014, 3 more Italian National Parks (Dolomiti Bellunesi NP, Stelvio NP, Val Grande NP), located in the Alps, started the same monitoring project. Currently, **6 Italian Parks,** all located in the Alpine Region and covering its natural variability, are sharing a common protocol to study animal biodiversity in mountain ecosystems.

Methods

24 altitudinal transects (550 - 2700 m a.s.l.), covering three vegetation belts (montane, subalpine, alpine), were distributed between the 6 Parks. In each transect we selected circular plots of 100 m radius (5-7 plots per transect), located along the altitudinal gradient and separated by an altitudinal range of 200 meters, for a total of **132 sampling stations** (Fig. 1).

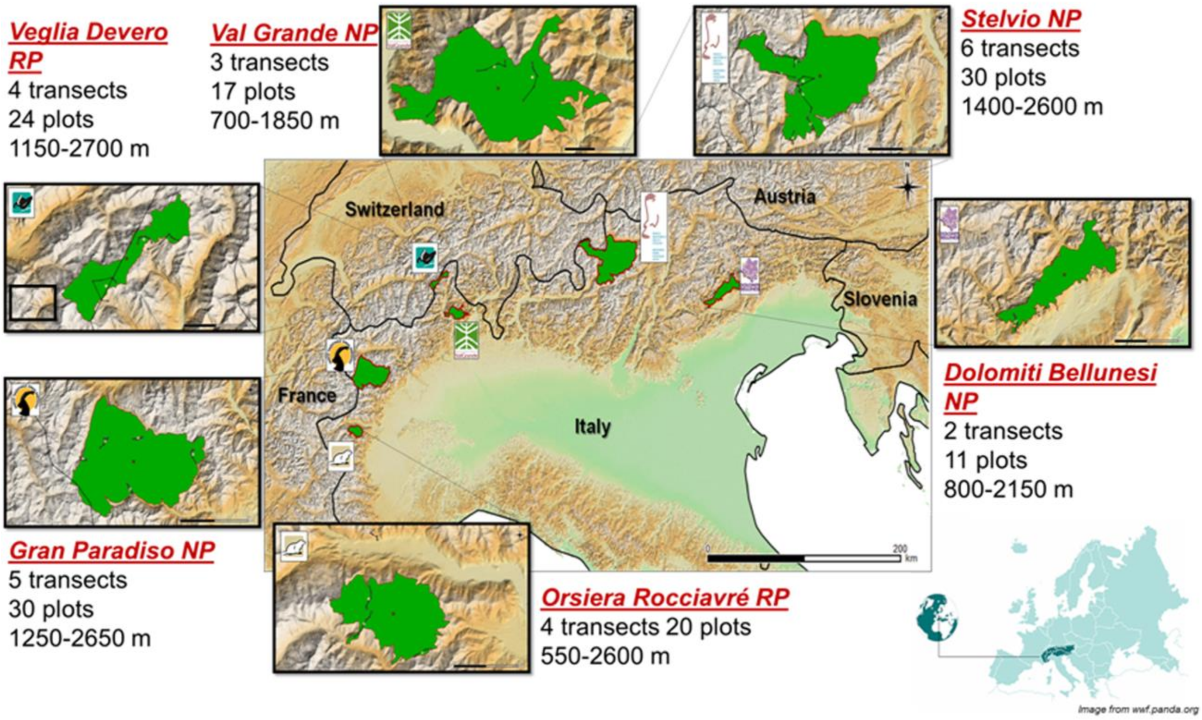

Figure 1: Protected areas involved in the projects with number of transects, plots and altitudinal range covered for each study area. RP=Natural (Regional) Park; NP=National Park.

In these plots, **7 taxa** were monitored, using standardized, easy to apply and cheap sampling techniques. **Birds** (*Aves*) were monitored by means of point counts and each plot was visited twice during the reproductive season. We sampled **butterflies** (Lepidoptera Rhopalocera) and **grasshoppers/crickets** (Orthoptera) using transects along the diameter of the plot (200 m in length), walked at uniform speed, once a month from May to September. We collected **surface-active arthropods** (Coleoptera Carabidae, Coleoptera Staphylinidae, Hymenoptera Formicidae, Araneae) using pitfall traps (plastic cups, diameter of 7 cm, filled with 10 cc of white vinegar, controlled every 15 days). In each plot, we also collected micro-climatic data, through the positioning of temperature data-logger (iButton DS1922) located in field for all the sampling season, topographic variables and micro-environmental parameters (in situ vegetation data).

Results and Discussions

Not all the data collected in 2012-2013-2014 are currently ready for all the 6 protected areas, but some patterns have already been recognised using data of the already available taxa (birds, butterflies and grasshoppers/crickets). We firstly focused on β-diversity expressed as total dissimilarity (Sørensen index), decomposed in its turnover and nestedness components. We observed that turnover is always higher than nestedness in all the cases. Canonical Analysis of Principal Coordinates has been used in a Variation Partitioning framework, to quantify the proportion of variation due to environmental and spatial factors. For all the taxonomic groups and for both the β-diversity components, altitude, habitat and climate explain more than the spatial factors. The spatial components have a higher role for invertebrates and the relative importance of space is higher for nestedness (Fig. 2).

We then used non-random occurrence of species along the altitudinal gradient to identify indicator species of the different altitudinal classes (DE CACERES & LEGENDRE 2009). Our results showed significant indicator species both at low and at high altitude, allowing us to identify altitudinal specialists (Fig. 3). Future changes in the distribution of these species across the Italian Alps can be considered a first signal of environmental transformations.

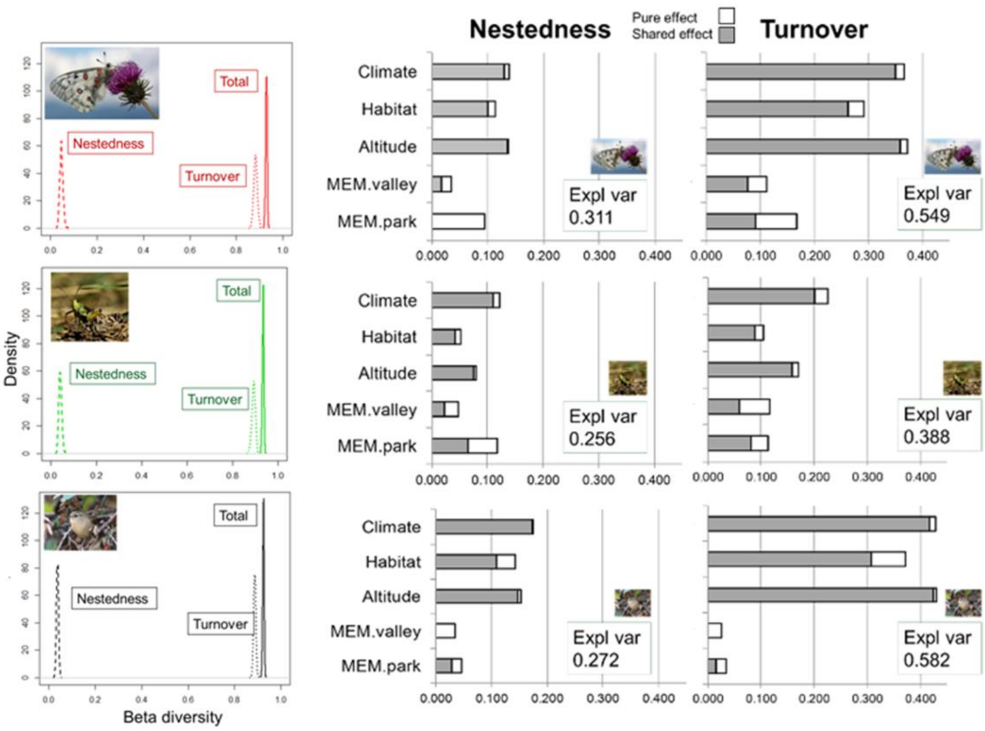

Figure 2: The total β-diversity and its two components (turnover and nestedness) were computed and analysed for the taxa with complete and already available datasets (butterflies, grasshoppers/crickets, birds). The relative importance of environmental and spatial factors in explaining the β-diversity components (nestedness and turnover) has been calculated through Canonical Analysis of Principal Coordinates (CAP) in a Variation Partitioning framework. Climate is represented by the Annual Mean Temperature and the Annual Precipitation from WorldClim. Habitat is a categorical variable, that considers the dominant vegetation type. Altitude is a continuous variable. Spatial component was modelled using Moran's Eigenvector Maps, from transect centroid (MEM.valley) and park centroid coordinates (MEM.park).

Low altitude specialists			
Altitudinal Bands		Indicator Species	
500-1000 m		*Parus caeruleus*	bird
1050-1400 m		*Parus major*	bird
1450-1800 m		*Aegithalos caudatus*	bird
1850-2200 m			
2250-2700 m			
500-1000 m		*Sylvia atricapilla*	bird
1050-1400 m		*Turdus merula*	bird
1450-1800 m			
1850-2200 m			
2250-2700 m			

High altitude specialists			
Altitudinal Bands		Indicator Species	
500-1000 m		*Colias phicomone*	butterfly
1050-1400 m		*Erebia pandrose*	butterfly
1450-1800 m		*Anthus spinoletta*	bird
1850-2200 m			
2250-2700 m			
500-1000 m		*Erebia epiphron*	butterfly
1050-1400 m		*Oenanthe oenanthe*	bird
1450-1800 m		*Aeropus sibiricus*	grasshopper
1850-2200 m			
2250-2700 m			

Figure 3: Indicator species (IndVal) for the different altitudinal classes. In grey are indicated the altitudinal bands that have significant indicator

species for the three taxonomic groups under analysis.

Conclusion

Such a network of protected areas, sharing the same monitoring protocol, offers the possibility to gain a better understanding of biodiversity pattern along altitudinal gradients and more robust evidence of the effects of climate and habitat changes on α- and β-diversity. Similar results, when available, can strongly improve the adaptive strategies of the protected areas.

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