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Applying a hierarchisation method to a biodiversity hotspot: Challenges and perspectives in the South-Western Alps flora

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ABSTRACT

The South-Western Alps host a great diversity of vascular plants, and especially endemic taxa. Thus, setting up a hierarchisation of patrimonial taxa of this biogeographical territory is needed in order to determine the main conservation concerns of flora. We adapted a hierarchisation method which leans on two criteria representing different kinds of rarity, and a third criterion which incorporates potential threats. This hierarchisation goes further than the objectives assigned to red lists and protection lists because it assesses taxa by taking into account the territorial context, using a standardised method, objective and reproducible. The classification of 913 patrimonial taxa into four concern categories aims to improve the available financial and human resources allocation for conservation measures.

1. Introduction

For many years, biodiversity decline has been a global concern; thereby the conservation of threatened taxa has become a major issue (Cardinale et al., 2012; Mace, Possingham, & Leader-Williams, 2007; Millennium Ecosystem Assessment, 2005; Vitousek, 1994). However, protection of all the taxa or ecosystems is not an achievable goal owing to wildlife's extreme diversity and finite allocated budgets. Setting up a hierarchisation of highest conservation concerns taxa is needed to define priority goals and to rationalise the means to implement conservation actions (Coates & Atkins, 2001; Gauthier, Debussche, & Thompson, 2010; Marsh et al., 2007). In fact, biodiversity conservation in a given area requires different steps. The first step is usually risk or threats assessment, for example setting up red lists of threatened species developed by the International Union for Conservation of Nature (IUCN). Setting up a hierarchisation is often a second step (Henle et al., 2013; Pullin, Sutherland, Gardner, Kapos, & Fa, 2013; Wilson, Carwardine, & Possingham, 2009); it could target geographical assets (e.g. Rodrigues et al., 2004) or biological assets, as habitats (e.g. Berg et al., 2014), species (e.g. Gauthier et al., 2010) or populations (e.g. Bonin, Nicole, Pompanon, Miaud, & Taberlet, 2007). The next step is usually conservation projects or actions priority-setting (e.g. Joseph, Maloney, & Possingham, 2009). Finally, the last step consists in conservation actions success assessment.

Current conservation needs rarely follow administrative areas, regulatory lists or threat status defined by red lists, especially in a relatively narrow area which includes regional biodiversity hotspots in which territory responsibility is highest (Keller & Bollmann, 2004; Schmeller et al., 2008). Red lists of threatened animal and plant species developed with IUCN criteria constitute an objective assessment of extinction risk in a given area, but do not constitute a priority list for species long term conservation, because they were not created for this purpose (IUCN, 2012). However, red lists are often mistakenly considered as a hierarchical list of priorities for conservation actions, and thus conservation priorities are mainly or even only based on extinction risk. Although extinction risk is a critical component of priority-setting systems, it is important to take into account other factors to maximise conservation actions efficiency (Fitzpatrick, Murray, Paxton, & Brown, 2007; Miller et al., 2006). Therefore, resource allocation based only on IUCN categories is not the most efficient way to help species recovery or to minimise extinction rates (Marsh et al., 2007). Likewise, regulatory lists are not directly applicable to select priority species because they

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often depend on policy resolutions, are subject to uncertainty of expert assessment and are spatially restricted (Jiménez-Alfaro, Colubi, & González-Rodríguez, 2010). However, priority lists can be used to set up protection lists (e.g. Gauthier et al., 2010; Martín et al., 2010; Schatz, Gauthier, Debussche, & Thompson, 2014).

A hierarchisation classifies assets according to selected criteria. Many approaches choose a great number of criteria, up to 30 criteria (e.g. Millsap, Gore, Runde, & Cerulean, 1990; Reece & Noss, 2014; Gaiarsa, Alencar, Valdujo, Tambosi, & Martins, 2015). Usually, these criteria can be gathered in 3 main groups: threats (or vulnerability), which is often assessed as taxa IUCN status, rarity (or local distribution), and territorial responsibility (or endemism or international importance) (e.g. Gauthier et al., 2010; Schatz et al., 2014). Beside these main criteria, other criteria are sometimes used, e.g. taxonomic distinctiveness, ongoing management, protection status, economic and social values, ecological feature… (e.g. Freitag & van Jaarsveld, 1997; Carter, Hunter, Pashley, & Rosenberg, 2000; Pärtel et al., 2005; Bacchetta, Farris, & Pontecorvo, 2012). Among the methods for targeting species, we can distinguish focal species selection methods and setting priorities methods, and among the latter we can distinguish « point-scoring » methods (or cumulative systems) and « rule-based » methods (or categorical systems) (Jiménez-Alfaro et al., 2010; Mace et al., 2007). Point-scoring methods are widely known, quantitative, reproducible and objective methods, and are based on readily measurable variables (Jiménez-Alfaro et al., 2010). In this study, we adapted the point-scoring method developed by Gauthier et al. (2010), a method which uses a small number of criteria, relatively easy to assess for a great number of taxa, and embodying the three main kinds of criteria. This method is easily reproducible and can be adapted to different administrative or biogeographical areas, different scales, and different plant groups. Different applications of the Gauthier et al. (2010) method (Gauthier, Foulon, Jupille, & Thompson, 2013; Kricsfalusy & Trevisan, 2014; Maciel, Oliveira-Filho, & Eisenlohr, 2016; Schatz et al., 2014) all used the three same criteria, but assessed them in different ways, according to their particular context.

The South-Western Alps, located at the interface between the Alps mountains and the Mediterranean region, host many endemic plants, with very restricted distribution areas but shared between two countries, France and Italy. Therefore, a hierarchisation of taxa not applied to an administrative area but to a biogeographical area is a consistent approach with global conservation concerns. In fact, the biogeographical conservation approach (e.g. Ladle & Whittaker, 2011) enables to improve the definition of protection issues which is often biased by approaches reduced to administrative areas and whose methods and objectives can vary from an area to another (Pärtel et al., 2005). Inside the Mediterranean basin, one of the 35 biodiversity hotspots on a global scale (Médail & Myers, 2004), Maritime and Ligurian Alps (which are an integrative part of South-Western Alps) constitute one of the 10 regional biodiversity hotspots. Biodiversity hotspots are defined as areas where exceptional concentrations of endemic species undergo exceptional loss of habitat (Myers, Mittermeier, Mittermeier, da Fonseca, & Kents, 2000). They are both an endemism centre and a glacial refuge for Mediterranean and alpine flora (Casazza, Zappa, Mariotti, Médail, & Minuto, 2008; Médail & Diadema, 2009; Noble & Diadema, 2011). The South-Western Alps have a great originality of flora with more than 150 endemic and subendemic taxa (Aeschimann, Rasolofo, & Theurillat, 2011). Moreover, with the population increase and tourism boom, many low altitude taxa are critically threatened of extinction (Médail & Verlaque, 1997; Noble et al., 2015; Salanon, Grandili, Kulesza, & Pintaud, 1994). Refuge areas, containing a great biodiversity, are also threatened by human impacts because they are submitted to important pressures (Médail & Diadema, 2006).

The purpose of this work is to rank patrimonial taxa of the South-Western Alps flora, a biodiversity hotspot, based on a limited number of standardised criteria readily available, aiming to prioritise their conservation concerns, and to compare this hierarchisation results with red lists and protection lists status.

2. Study area and taxa

2.1. Study area

The study area corresponds to the definition of the South-Western Alps according to Aeschimann et al. (2011), extended to Provençal peripheral mountains, because it matches the distribution ranges of many endemic species (e.g. *Berardia subacaulis, Campanula rotundifolia* subsp. *macrorhiza, Fritillaria involucrata, Helictotrichon sempervirens, Sempervivum calcareum* etc.). In order to implement an efficient conservation, the study area must reflect the real distribution of species, not administrative boundaries. This geographical unit is not strictly homogeneous from a biogeographical point of view, because it is located at the limit between temperate Europe and the Mediterranean basin (Takhtajan, 1986), but it is a consistent ensemble in terms of geomorphology, in relation to its geological history, and reflects the reality of biological processes. This territory is a continuum from Mediterranean to alpine environments, going from sea level to more than 4000 m above the sea level. This particular location is one of the explanatory components of diversity and originality of the flora of this area (Noble & Diadema, 2011). The study area (Fig. 1) extends on about 43,000 km^2:5000 km^2 in Italy (12%) and 38,000 km^2 in France (88%). 80% of Provence-Alpes-Côte d'Azur region (PACA, France) and 50% of Liguria region (Italy) are included in the study area. Two other administrative regions are also marginally included: Auvergne-Rhône-Alpes (France) and Piemonte (Italy).

2.2. Taxonomic targets

This work targets patrimonial taxa (vascular plants and mosses) which include: (i) endemic or subendemic taxa in the study area, (ii) threatened taxa, and (iii) taxa protected by law.

Endemic taxa distribution is entirely included in the study area and subendemic taxa distribution is included at least at 80% in the study area. Threatened taxa are classified in IUCN categories: CR (critically endangered), EN (endangered) or VU (vulnerable) in the national red lists in France and in Italy, or in the regional red lists in Liguria, Piemonte and Provence-Alpes-Côte d'Azur (PACA) (Arillo et al., 2005; Noble et al., 2015; Rossi et al., 2013; UICN France, FCBN, MNHN, 2012). Protected taxa have a protection status at European, national (France or Italy) or regional (Liguria, Piemonte, PACA or Auvergne-Rhône-Alpes) levels. Exogenous taxa were excluded from this analysis, just as those not found since 1990. In total, 913 taxa are ranked, which represents about a quarter of the indigenous flora of the study area.

The occurrence data come (i) from the database SILENE-Flore of the Conservatoire botanique national méditerranéen de Porquerolles (CBNMed) and the Conservatoire botanique national alpin (CBNA) (http://flore.silene.eu) for PACA region, (ii) from the flora database of CBNA for Auvergne-Rhône-Alpes region, (ii) from the Libios database of the Agenzia Regionale per la Protezione dell'Ambiante Ligure (ARPAL) and of the Parco Naturale del Marguareis for Liguria region, and (iv) from the database of the Parco Naturale Alpi Marittime for Piemonte region. These geo-localised data were combined through a web-service developed in the framework of European program Alcotra n°192 BIODIVAM (http://biodivam.eu) based on a shared taxonomic reference document adapted for the study from TAXREF V5 (Gargominy et al., 2012) for France and from Pignatti (1982) for Italy. In total almost 400,000 occurrence data were used in this work.

3. Methods and results

3.1. Selection and quantification of criteria

This hierarchisation method for taxa is adapted from the point-