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At the intersection of cultural and natural heritage: Distribution and conservation of the type localities of Italian endemic vascular plants

Giuseppe Brundu[a,*,1], Lorenzo Peruzzi[b,1], Gianniantonio Domina[c,1], Fabrizio Bartolucci[d,1], Gabriele Galasso[e,1], Simonetta Peccenini[f], Francesco Maria Raimondo[g], Antonella Albano[h], Alessandro Alessandrini[i], Enrico Banfi[e], Giuseppina Barberis[f], Liliana Bernardo[j], Maurizio Bovio[k], Salvatore Brullo[l], Antonello Brunu[a], Ignazio Camarda[a], Luisa Carta[a], Fabio Conti[d], Antonio Croce[m], Duilio Iamonico[n], Mauro Iberite[o], Gianluca Iiriti[p], Daniela Longo[f], Stefano Marsili[f], Pietro Medagli[h], Mauro Giorgio Mariotti[f], Riccardo Pennesi[q], Annalaura Pistarino[r], Cristina Salmeri[g], Annalisa Santangelo[m], Elisabetta Scassellati[o], Federico Selvi[s], Adriano Stinca[t], Gabriella Vacca[a], Mariacristina Villani[u], Robert Philipp Wagensommer[v], Nicodemo Giuseppe Passalacqua[w,1]

[a] Dipartimento di Agraria, Università di Sassari, Viale Italia 39, 07100 Sassari, Italy
[b] Dipartimento di Biologia, Università di Pisa, Via Derna 1, 56126 Pisa, Italy
[c] Dipartimento di Scienze Agrarie, Alimentari e Forestali, Università di Palermo, Via Archirafi 38, 90123 Palermo, Italy
[d] Scuola di Bioscienze e Medicina Veterinaria, Università di Camerino – Centro Ricerche Floristiche dell'Appennino, Parco Nazionale del Gran Sasso e Monti della Laga, San Colombo, 67021 Barisciano, L'Aquila, Italy
[e] Sezione di Botanica, Museo di Storia Naturale di Milano, Corso Venezia 55, 20121 Milano, Italy
[f] Dipartimento di Scienze della Terra, dell'Ambiente e della Vita, Università di Genova, Corso Europa 26, 16132 Genova, Italy
[g] Dipartimento di Scienze e Tecnologie Biologiche, Chimiche e Farmaceutiche, Università di Palermo, Via Archirafi 38, 90123 Palermo, Italy
[h] Dipartimento di Scienze e Tecnologie Biologiche ed Ambientali, Università del Salento, Via Prov.le Lecce-Monteroni, 73100 Lecce, Italy
[i] Istituto Beni culturali Regione Emilia-Romagna, Via Galliera 21, 40121 Bologna, Italy
[j] Dipartimento di Biologia, Ecologia e Scienze della Terra, Università della Calabria, 87036 Arcavacata di Rende, Cosenza, Italy
[k] Via Saint-Martin de Corléans, 151, 11100 Aosta, Italy
[l] Dipartimento di Scienze Biologiche, Geologiche e Ambientali, Università di Catania, Via A. Longo 19, 95125 Catania, Italy
[m] Dipartimento di Biologia, Università degli Studi di Napoli Federico II, Via Foria, 223, 80139 Napoli, Italy
[n] Dipartimento di Pianificazione, Design, Tecnologia dell'Architettura, Università di Roma "La Sapienza", Via Flaminia 72, 00196 Roma, Italy
[o] Dipartimento di Biologia Ambientale, Università di Roma "La Sapienza", Piazzale Aldo Moro 5, 00185 Roma, Italy
[p] Hortus Botanicus Karalitanus (HBK), Centro Servizi di Ateneo, Università degli di Cagliari, Viale Sant'Ignazio da Laconi, 9-11, 09123 Cagliari, Italy
[q] Dipartimento di Scienze della Vita, Università di Trieste, Via L. Giorgieri 10, 34127 Trieste, Italy
[r] Museo Regionale di Scienze Naturali, Via G. Giolitti 36, 10123 Torino, Italy
[s] Dipartimento di Scienze delle Produzioni Agroalimentari e dell'Ambiente, Laboratori di Botanica Ambientale ed Applicata, Università di Firenze, P.le Cascine 28, 50144 Firenze, Italy
[t] Dipartimento di Agraria, Università di Napoli Federico II, Via Università 100, 80055 Portici, Napoli, Italy
[u] Centro di Ateneo Orto Botanico dell'Università di Padova, Via Orto Botanico 15, 35121 Padova, Italy
[v] Dipartimento di Chimica, Biologia e Biotecnologie, Università di Perugia, Via del Giochetto 6, 06123 Perugia, Italy
[w] Orto Botanico, Università della Calabria, Via Savinio, 88030 Arcavacata di Rende, Cosenza, Italy

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ABSTRACT

We conducted a GIS spatial analysis with the aim of providing the first quantitative large-scale overview of the distribution patterns of 1536 type localities (*loci classici*) of 1216 Italian endemic vascular plants and their relationship with a set of descriptive variables. Whereas some variables were used to model the presence-absence distribution patterns of the type localities for the whole set of endemics as well as for the subset of narrow endemics, others (e.g., presence inside or outside protected areas and Italian Important Plant Areas) were considered with the purpose of assessing potential assets or risks for conservation.

The largest number of type localities was found within the Mediterranean biogeographic region (1134),

* Corresponding author.
E-mail addresses: gbrundu@uniss.it (G. Brundu), lorenzo.peruzzi@unipi.it (L. Peruzzi), gianniantonio.domina@unipa.it (G. Domina), fabrizio.bartolucci@gmail.com (F. Bartolucci), gabriele.galasso@comune.milano.it (G. Galasso), nicodemo.passalacqua@unical.it (N.G. Passalacqua).
[1] These authors equally contributed to the paper.

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followed by the Alpine region (306) and Continental region (96). A total of 670 locations are located on islands, whereas 866 are located on the Italian mainland (139 and 124 in the case of narrow endemics, respectively). A large number of type localities are located in mountainous areas and along the coastline, which can be seen as a potential risk for conservation. On the contrary, we detected a positive correlation with the distance from roads, which might be considered to be an asset. Importantly, 1030 type localities fall inside protected areas, whereas 506 localities fall outside protected areas, with 259 of these unprotected localities on islands.

We propose considering the results of the analysis of the distribution of type localities of Italian endemics to be a strategic tool for conservation planning and resource management. Application of plant micro-reserves and integration of diverse legislation tools are suggested to strengthen efforts and increase conservation success.

1. Introduction

It is generally agreed that among the most pressing issues challenging the global conservation community is how to identify biodiversity-rich areas and distribute limited resources between regions identified as priorities for biodiversity conservation (e.g., Cañadas et al., 2014; Wilson et al., 2006). However, biodiversity is a complex multifaceted concept that includes scales in space and time, and areas of high priority for conservation may be defined on the basis of habitat and species richness, endemism, genetic or phylogenetic diversity, the probability of species' extinctions or other indices (Ferreira and Boldrini, 2011; Li et al., 2015; Myers et al., 2000; Orme et al., 2005; Pavoine and Bonsall, 2011; Pouget et al., 2016; Schmeller et al., 2014). For example, Bonner (1984) discussed the criteria that were used to decide whether sites should be awarded the status of “Special Protected Areas” in Antarctica. Five criteria were used, including type localities. Importantly, since Moreau et al. (1945), it has been remarked that, in systematic zoology, particularly that dealing with land vertebrates, the accurate definition of the geographical position of the localities from which taxa have been described by authors is no less essential than a clear definition of the characters of the animals themselves.

The collection and analysis of biological data required for these assessments are always time consuming and expensive, particularly for rare species (Ahrends et al., 2011). Despite its importance for conservation, such work is chronically underfunded (Balmford and Gaston, 1999; Platts et al., 2014), many information gaps exist (Meyer et al., 2015) and biodiversity loss is arguably proceeding more rapidly than the documentation of species distributions and genetic diversity (Cardinale et al., 2012; Kier et al., 2009).

As a contribution to the assessment of the national floristic biodiversity, during 2012–2014, a group of botanists of the *Società Botanica Italiana* (Italian Botanical Society) published the first inventory of the type localities (*loci classici*) of 1400 Italian endemic vascular plants (Peruzzi et al., 2015). Type localities are the geographical locations documented by the valid publication of plant basionyms, accepted names and homotypic synonyms.

Type localities are point data and, as such, cannot be considered a robust proxy for the distribution, abundance and conservation status of the populations of the Italian endemics. However, in the case of the very narrow Italian endemics, we can expect to acquire useful ecological information from analysing the distribution pattern of their type localities because these locations are adequately representative of the whole ecological niche of these species and are particularly worthy of being protected. When species are known only from their type locality, the use of type locality is generally assumed as a criterion closely related to the criterion of endemicity (Bonner, 1984).

Furthermore, type populations are of fundamental importance in theoretical and applied taxonomy and biodiversity conservation (e.g., Hernandez-Kantun et al., 2015; Larridon et al., 2014). Many taxonomic conclusions can be drawn directly from the study of type specimens (the specimens to which scientific names are attached, usually *exsiccata*, i.e., dried plant specimens), but this is often not satisfactory. For many types of biosystematics studies, living specimens and samples from living populations are required (e.g., Cieślak et al., 2006; Flanagan et al., 2006; Hong and Zhou, 2003). These studies require the collection of germplasm or specimens in type localities, i.e., those localities from where the nomenclatural types were originally collected. Only this procedure will ensure that the results obtained (e.g., the chromosome number, DNA sequences, a diaspore collection for ex situ conservation purposes, and species trait analysis) will certainly apply to a certain taxon and will be taxonomically sound. Accordingly, the knowledge and conservation of these peculiar type populations and of the related sites are of crucial importance in comparative biology. In addition, these localities represent a very important cultural and historical heritage, being places that are visited, studied or described by relevant personalities in the history of botany and plant biology in general.

Species distribution models can help scientists and conservation planners estimate centres of biodiversity (Barthlott et al., 2005; Brotons et al., 2004) and identify priority areas for conservation (Elith and Leathwick, 2009) as well as patterns of major threats across the landscape, such as habitat loss, fragmentation and other anthropogenic pressures (e.g., Aben et al., 2016; Ibáñez et al., 2009; Newbold et al., 2016). In contrast, one dilemma with mapping concerns which species should be evaluated because it is impossible to map them all (Miller and Allen, 1994; Mittermeier et al., 2004; Trisurata et al., 2012). Species confined to very small distribution areas, so-called narrow endemic species (Andersen et al., 1997; Kruckeberg and Rabinowitz, 1985; Williams et al., 1996), pose very important conservation issues due to their great vulnerability to extinction (Raedig et al., 2010) and could be considered as a priority for action, including modelling and mapping efforts. A second dilemma with mapping concerns the fact that revealing geographical locations in publications can guide unscrupulous collectors from the international trade to the species, which could lead to a rapid decline in population size and even extinction (Stuart et al., 2006).

Point data, such as museum and herbarium specimen data (Rivers et al., 2011), have proven useful for the generation of species ranges (Raedig et al., 2010, and references cited therein). However, there also exist some inherent drawbacks, such as the heterogeneous sampling of space and taxa because of varying accessibility of areas, limited resources, varying attractiveness of taxa to collectors and systematic or geographical inaccuracy, for example due to efforts associated more with political and administrative rather than ecological boundaries (Cadenasso et al., 2003; Ferreira and Boldrini, 2011; Knapp, 2002; Meyer et al., 2015; Raedig et al., 2010).

To better explore the geographical distribution pattern of the whole group of type localities, on the basis of the Italian national inventory, we conducted a GIS-assisted spatial analysis specifically aiming to provide the first quantitative overview of the distribution patterns and to assess the relationship between the actual distribution of type localities and a set of descriptive variables.

To the best of our knowledge, this is the first time that this type of analysis has been applied to such a large data-set of type localities at a country level in Europe or anywhere else in the world.