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## Towards a Red List of the terricolous lichens of Italy

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### ABSTRACT

Terricolous lichens, threatened in many areas of Europe, have been greatly overlooked in conservation policies. This work provides a provisional Red List of the terricolous lichens of Italy, to favour their inclusion in conservation policies. The taxa were assigned to IUCN categories according to a simplified assessment procedure based on their rarity and past/current distribution in the administrative regions and ecoregions of Italy. We evaluated 162 species: 30 were listed as regionally extinct, 22 critically endangered, 16 endangered, 49 vulnerable, 27 near-threatened, 7 least-concern, and 11 data deficient. A quarter of the terricolous lichens of Italy is likely to be threatened, but a rigorous assessment is hindered by the scarcity of data. Further field work is needed for more precise assessments of their conservation status.

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Biodiversity; conservation; floristics; historical collections; lichen biota; Natura 2000 Network

### Introduction

Lichens are considered to be optimal indicators of environmental quality (ANPA 2002). Terricolous lichens, being particularly sensitive to anthropogenic impact, are therefore threatened in many areas of Europe, mainly due to habitat loss and fragmentation, air pollution and global change (Scheidegger and Clerc 2002). Unfortunately, these organisms have been greatly overlooked in conservation policies, and only in the last decade they have gained the attention of Italian lichenologists, who focused on the effects of habitat loss and global change (Gheza et al. 2018, 2020, 2021a; Di Nuzzo et al. 2021; Vallese et al. 2021).

In biological conservation, Red Lists play an important role, addressing the attention towards the most threatened species. Red Lists including terricolous lichens are available for several European countries, but not for Italy. The first Red List of Italian lichens (Nimis 1992) included several terricolous species, but it was based on still fragmentary data and old criteria, which hindered its integration in official conservation policies. Another Red List, that follows more modern IUCN criteria, albeit simplified for fungal species (Dahlberg and Mueller 2011), included epiphytic lichens only (Nascimbene et al. 2013). A strict application of IUCN assessment procedures was used only for a few terricolous species of conservation concern (*Cladonia* subgenus *Cladina*: Ravera et al. 2016).

Red-listing is a complex procedure that requires accurate data which are not always available for understudied organisms, as lichens. Mainly for this reason, a strict application of the IUCN criteria is not always possible for fungal species,

so that for lichens the assessment of the conservation status was often based on a simplified approach (Nascimbene et al. 2013).

This work aims at providing a provisional Red List of the terricolous lichens of Italy which could be useful to enhance their inclusion in conservation policies, but also to highlight gaps in current knowledge.

### Materials and methods

A preliminary selection was carried out, leading to a list of 162 infrageneric taxa to assess for the Red List, out of the 452 terricolous lichens occurring in Italy (36%). The assessment was performed following Dahlberg and Mueller (2011) and the framework by Nascimbene et al. (2013), mainly evaluating data on rarity and past/current distribution of the taxa in the 20 administrative regions and the 9 ecoregions of Italy (Nimis 2016), to obtain an estimate of their trends and extinction risk. A detailed account of the assessment procedure is reported in [Supplementary File 1](#).

### Results

Overall, 162 infrageneric taxa were assessed for the attribution to IUCN categories ([Supplementary File 2](#)), and 117 of them (72% of assessed taxa and 26% of terricolous lichens of Italy) were attributed to a threatened or extinction category. Among them, 30 taxa were not reported in the last 50 years, 85 showed a declining trend, and 41 are known from a single

locality. Many taxa have not been reported from at least one of the 20 administrative regions of Italy in the last 50 years.

The 30 taxa (19%) not reported from any Italian region in the last 50 years have been assessed as “regionally extinct” (RE). The 22 taxa (14%) known from a single locality in Italy in the last 50 years have been assessed as “critically endangered” (CR). Sixteen taxa (10%) have been assessed as “endangered” (EN), 49 (30%) “vulnerable” (VU), and 27 (17%) “near threatened” (NT). Most of them showed a decline in the last decades, i.e., were reported from fewer regions in the last 50 years. Only 7 taxa were assessed as “least concern” (LC). The remaining 11 taxa, with insufficient information, were classified as “data deficient” (DD); they are mainly species reported as new to Italy in the last 10 years.

## Discussion

The data gathered for this assessment paint a troubling picture for the terricolous lichens of Italy. Similarly to epiphytic species (Nascimbene et al. 2013), about a quarter of the terricolous lichens were assessed as threatened or already virtually extinct, but this may be due to a real extinction or just to scarce knowledge; more intense field studies, especially in previously overlooked habitats and for recently described taxa, may lead to the rediscovery of taxa assessed as RE or CR.

Scarce data hinder rigorous assessment procedures. A simplified procedure can lead to an overestimation of the species assessed as extinct, but also to an underestimation of the assigned categories. A comparison between a strict assessment with IUCN criteria vs our simplified assessment is possible only for three species assessed as EN by Ravera et al. (2016), i.e., *Cladonia ciliata*, *C. mediterranea* and *C. portentosa*, which were assessed by us as NT, LC and NT, respectively.

The first “Golden Age of Italian lichenology” in the mid-19th century was followed by almost a century of inactivity (Nimis 1993), until the late-20th century, when there was a first phase of new explorations that soon led to a phase of synthesis of historical and newly collected data, culminating with the publication of two national checklists (Nimis 1993, 2016) and an online database updated in real time and supplemented with identification keys (Nimis and Martellos 2021). Recent developments have provided a priceless working basis, but have also highlighted the still insufficient knowledge, and should be considered as a starting point for a new analytical phase, made possible thanks to the recent tools for species identification and concerning not only mere floristics but also other urgent topics (Supplementary File 3).

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## Disclosure statement

The authors declare that they have no conflict of interests.

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