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The Important Plant Areas program from a mycological point of view: the regional experience in an European context.

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Abstract
In activities for conservation of biodiversity and habitats fungi were usually disregarded in spite of their great ecological role. Thanks to the IPA program, a target of the European and Global strategies for Plant Conservation, also the so called lower plants are included and this improve the position of fungi in the complex of nature conservation programs.
The ECCF (European Council for the Conservation of Fungi), founded in 1985, aims to promote the attention for the conservation of Fungi to all governmental bodies and non-governmental organisations and stimulate the publication of national and regional Lists of threatened fungi. The publication of Red Lists is one of the basic activities to support the conservation strategies and allows the application of Criterion A, among the IPA selection criteria. In spite of the fundamental work of ECCF, only a third of European countries has a Red List of fungi.
In Tuscany first attempts to apply the IPA criteria to the *Regnum Fungi* dates back to the first years of the new millennium; the publication of a Tuscan Red List and participation at the national IPA project have been fundamental.
In this work the IPA criteria, are analyzed from a mycological point of view and utilized to select the "Montagnola Senese" as important plant/fungus area.

Keywords: conservation, mycological reserves, macromycetes, Tuscany.

Riassunto
Il progetto Aree Importanti per le Piante da un punto di vista micologico: l'esperienza regionale in un contesto Europeo
I funghi, nonostante sia ben noto l'importante ruolo ecologico che svolgono, vengono raramente presi in considerazione nelle varie iniziative di conservazione della biodiversità e politiche di salvaguardia della natura. Grazie alle strategie europee per la conservazione il significato di piante viene interpretato in sensu lato e non si riferisce solo alle piante vascolari, ma include anche briofite e alghe nonchè anche funghi e licheni. Uno degli obiettivi prioritari dei programmi europei, che a loro volta sono inseriti in quelli globali, è l'identificazione di siti di particolare interesse conservazionistico ovvero Important Plant Areas (IPAs). Indispensabile strumento per l'applicazione del criterio A del progetto IPAs è la compilazione di liste di specie rare o minacciate e in questo contesto di particolare rilievo è il lavoro svolto dall'ECCF (European Council for the Conservation of Fungi), organizzazione fondata nel 1985 con lo scopo di promuovere l'attenzione per la conservazione dei funghi e di stimolare la pubblicazione di liste rosse.
Sin dall'inizio del nuovo millennio vari sono stati gli approcci per individuare in Toscana aree importanti per i macromiceti e sia la pubblicazione della lista di funghi minacciata in Toscana che la successiva partecipazione al progetto IPA nazionale sono stati fondamentali.
In questa sede la Montagnola Senese viene selezionata applicando i criteri IPA come area importante da un punto di vista micologico.

Parole chiave: Conservazione, riserve micologiche, macrofunghi, Toscana.

Introduction

Conservation of biodiversity has nowadays acquired a widespread credibility and after the Rio Convention (1992) many global, national and local initiatives have been established with the goal to reduce or halt the current loss of biodiversity mainly in respect to habitats, animals and plants. Fungi were generally overlooked in nature conservation initiatives even if their sometimes, strange appearance/disappearance was observed and finally their ecological role and importance was accepted. It is clear that there is a strong link among the numerous different organism and between them and the environment and that habitat conservation could provide protection for all existing life in the selected site. On the other hand it must be remembered that not always the selected areas are of great conservation value also for fungi and/or that not always targeted management is beneficial also for fungi.

This and similar topics are not new in mycological meetings and thanks to the European Council of Conservation of Fungi (ECCF), founded in 1985, the co-operations and the initiatives to safeguard at least macromycetes were various (Arnolds & Kreisel, 1992; Jansen & Lawrynowicz, 1991; Perini, 1998; Perini *et al*., 2008). 2 actions at the European Council of Strasbourg must be remembered: a) the proposal of 33 larger fungi threatened at European level to be included in the Bern Convention, finally after more than 20 years registered (document T-PVS (2001), 34) and published in their review (Dahlberg & Croneberg, 2003; 2006), b) the production of a guidance for conservation of macrofungi in Europe (Senn-Irlet *et al*., 2007). In the new millennium during a conference where also researcher from outside Europe participated, issues and solution just on the topic Fungal conservation were discussed: "...whether

and how fungi could be conserved... should it be the site, the habitat, or the host...?" (Moore *et al*., 2001). Different approaches principally from central-northern Europe countries, but relatively rare on a global level in respect to other organisms, can be mentioned. In Norway since the 90'ies key biotopes, also for fungi and principally wood inhabiting ones, were established (see, e.g. Bendiksen 1994). As Bendiksen reports: "...red listed mycetes have been the main reason for establishment of many forest reserves, a lot of key biotopes etc. and have even in rare cases been the deciding factor in staking out new roads...!" Moreover "...farmers are encouraged to manage such areas in the way taking best care of ecologically specialized fungi and plants by special economical measures..." (Bendiksen, 2006). In The Netherlands a permanent Committee for Fungi and Nature Conservation inside the Netherlands Mycological Society compiles data on mycological value in particular areas and a paper was published in the late 90'ies about the 200 most important mycological areas, the so called 'crown-jewels' (Jalink, 1999).

As written in the ECCF newsletter n. 15 (www.wsl.ch/eccf/) reporting mycological activities of the years 2000-2005, nowadays also other approaches are underway. Anyway in respect to the high diversity of the *Regnum Fungi* they are relatively few and alone standing, restricted principally to single central-northern Europe countries and often only to wood-inhabiting fungi. In fact it seems that only Croatia made surveys for 52 important sites for fungi inside the European Natura 2000 project (Mesic & Tkalcec, 2006).

Thanks to the IPA program, a target of the two European Plant Conservation Strategies (2002-2007; 2008-2014) and of the Global one, also fungi at the same level of plants were included among the actors (Smart *et al*., 2002; Planta Europa, 2008). The IPA project gives the possibility to become part of conservation actions to countries, habitats and organisms - in some way not considered in the HABITAT DIRECTIVE 92/43/CEE. The selection of good sites is based on the presence of rare, threatened and/or endemic species (criterion A), on exceptional species richness (criterion B), on habitat with high value (criterion C) (Anderson, 2002). In order to apply this precise and apparently simple criteria a good background of information with reliable data on distribution, ecology and threat status is necessary. Unfortunately, in respect to botany and zoology, mycology has been explored much less and this because of the various difficulties in studying them, the high diversity of fungi and the very low numbers of mycologists. In spite of the fundamental work of the European Council for the Conservation of Fungi (ECCF), only a third of European countries has now an official Red List of fungi while Croatia is the only one within the Mediterranean Biogeographical Zone. A European Red List for larger fungi is still lacking, but as a result of a hard co-operation among European scientists a list of candidates of threatened European fungi is now available on-line (http://www.wsl.ch/eccf). Even if with difficulties European mycologists are ready and demonstrate through its networks that the knowledge could be sufficient to work for the protection also of this group of organisms.

In Europe the IPA programme started in the not EU countries in central-east and went on in south-east and various selected areas results important also from a mycological point of view (Anderson *et al*., 2005**;** Radford & Odé, 2009). In the European IPA context, Italy, involving various experts, plays an important role with an innovative national project, funded by the Ministry of Environment, Land and Sea Protection, that goes over the IPA project adding other data such as the landscape aspect (Blasi *et al*., 2007; 2009; 2010; 2011). Even if Italy lacks of a fungi Red list, the presence of a checklist of Basidiomycetes (Onofri *et al*., 2005), the work towards preliminary Red lists (Venturella *et al*., 1997; 2002), and a new list of endangered fungi proposed for the national IPA project, in addition to the 33 fungal species proposed for inclusion in the Bern Convention, enabled Italian mycologists to collaborate.

The participation at this national network was fundamental for the group of mycologists of the University of Siena, whose first attempts to apply the IPA criteria to the *Regnum Fungi*, encouraged by the publication of a similar work done in the United Kingdom selecting IFA (Evans *et al*., 2002)**,** dates back to the first years of the new millennium (Parmasto *et al*., 2004; Perini & Laganà, 2003; Perini & Salerni, 2004). Till now various areas described in previous works result as possible key-sites for fungi (I fase internal report, 2006; Blasi *et al*., 2009; 2010; 2011; Leonardi *et al*., 2008, 2010).

In this paper the "Montagnola Senese" is proposed as an important fungi site and is analyzed from a mycological point of view. A new approach applying the candidates for a future European Red list focusing critically on the Mediterranean Biogeographical Zone and not at least the recently published Tuscan Red list for larger fungi (Antonini & Antonini, 2006) is also reported.

Materials and methods

According to the IPA programme the selection of an interesting site to protect is based at least on one of 3 given criteria:

"Criterion A: The site holds significant populations of one or more species that are of global or European conservation concern.

Criterion B: The site has an exceptionally rich flora in a European context in relation to its biogeographical zone.

Criterion C: The site is an outstanding example of a habitat type of global or European plant conservation and botanical importance." (Anderson, 2002).

Concerning criterion A based on list of threatened species, no fungi are present on a global scale with exception of *Pleurotus nebrodensis* – an endemic species of Sicily – listed as critically endangered in "The Top 50 Mediterranean Island Plants" (Montmollin & Strahm, 2005). As agreed among scientist at an European level the list of 33 macromycetes proposed for inclusion in the Bern Convention is followed (Dahlberg & Croneborg 2003; 2006). Moreover useful are the 1644 taxa considered to be threatened in Europe and reported on-line as candidates for a future Red list (http://www.wsl.ch/eccf). Finally, because of the lack of a national Red list, the Tuscan one, where 471 species have been evaluated using the IUCN criteria, is consulted (Antonini & Antonini, 2006). The use of this list can be justified because it is so far the only one published in Italy if we don't consider the proposals at national level. Moreover it reports the status of fungi of an extended surface and various habitats compared with other small countries that works with Red lists and mycological reserves; in fact Tuscany covers a vast territory (almost 23.000 km^2) from the Thyrrenian sea up to a the Apennines through a 66% of hilly area and 25% of mountain zone.

Study Area

The "Montagnola Senese", a hilly area around 500-600 m a.s.l reaching the altitude of 671 on the Mount Maggio, is geographically well defined and not far west-side from Siena (Italy) (Lat.: 43°20'15" Long.: 11°11'15"). It is proposed as a district deserving protection because of high floristic and vegetational interest, an area to be protected in the regional system, a Site of Community Importance (Habitat Directive 92/43/EEC) (Manganelli & Favilli, 2001). The geological nature is very complex and includes Mesozoic and Paleozoic carbonate-argillaceous-silicious formations and the geological substrate of the main areas investigated mycologically is dark-grey breccia-like with a typically spongy surface known as "calcare cavernoso" (Lazzarotto, 1993). The climate according to Thronthwaithe is subhumid, mesothermic and with a moderate summer drought (Barazzuoli *et al*., 1993).

This sub-mountain area is mainly woody with deciduous and evergreen oakwoods (*Quercus pubescens, Q. cerris, Q. ilex*, sporadic *Q. petraea* and *Q. robur*), chestnut-woods, rare cultivations, some small pastures and interesting grasslands are also present (De Dominicis, 1993).

Results and discussion

The "Montagnola Senese" in its whole and principally the oakwoods, were and still are a preferred destination for mycological collections. Not only many floristic excursions of Tuscan and foreign mycologists have been done, but also specific mycocoenological observations in permanent plots over various years with qualitative and quantitative observations have been carried out (Antonini & Antonini, 2006; Barluzzi *et al*., 1992; 1997; Laganà *et al*., 1999; 2002; Perini *et al*., 2004; Salerni *et al*., 1998, 2001; not published data). In more than 40 years of different mycological surveys in the "Montagnola Senese" 515 fungal taxa can be listed.

On the basis of criterion A, among the conspicuous number of macrofungi collected, there are 60 species with great conservation value because of their threat status due to natural or anthropic action (Tab. 1). 33 out of these species are included among the candidates for a European Red Lists (http://www.wsl.ch/eccf) and 14 are also considered in the Tuscan Red List (Antonini & Antonini, 2006) (Tab. 1). To note *Boletus dupainii* and *Leucopaxillus compactus,* the only two included in the list of mycetes proposed for the Bern Convention Appendix (Dahlberg & Croneborg, 2003, 2006). Moreover both species are listed among the European candidates as vulnerable in the Mediterranean zone (Croatia). The first taxon is also one of the macromycetes critically analyzed in Italy and reported as "vulnerable" (VU) (Perini & Venturella, 2008) and in Tuscany classified as "endangered" (EN) (Antonini & Antonini, 2006). From the European network (data are still to be published) the second species seems to be more endangered in northern countries, maybe increasing in the Alpine zone but few observations

Species	T	ERL	BC
Agaricus augustus Fr.	X		
Amanita strobiliformis (Paulet ex Vittad.) Bertill.	X		
Boletus appendiculatus Schaeff.	X		
Boletus dupainii Boud.	X	X	X
Boletus pulchrotinctus Alessio	X		
Boletus radicans Pers.	X		
Boletus rhodopurpureus Smotl.		X	
Boletus satanas Lenz	X		
Bovista aestivalis (Bonord.) Demoulin	X		
Camarophyllopsis foetens (W. Phillips) Arnolds	X		
Coprinus episcopalis P.D. Orton		X	
Cortinarius aleuriosmus Maire	X	X	
Cortinarius bolaris (Pers.) Fr.	X		
Cortinarius dibaphus Fr.	X		
Cortinarius odoratus (M.M. Moser) M.M. Moser		X	
Cortinarius prasinus (Schaeff.) Fr.	X	X	
Cortinarius semisanguineus (Fr.) Gillet	X		
Cortinarius sodagnitus Rob. Henry	X		
Cortinarius suaveolens Bataille & Joachim	X	X	
Dendrocollybia racemosa (Pers.) R.H. Petersen & Redhead	X	X	
Dermoloma cuneifolium (Fr.) Singer ex Bon	X		
Entoloma byssisedum (Pers.) Donk	X		
Entoloma corvinum (Kühner) Noordel.	X	X	
Entoloma incanum (Fr.) Hesler	X		
Entoloma mougeotii (Fr.) Hesler	X	X	
Entoloma sinuatum (Bull.) P. Kumm.		X	
Hebeloma album Peck	X		
Hydnellum auratile (Britzelm.) Maas Geest.		X	
Hydnellum peckii Banker	X	X	
Hydropus floccipes (Fr.) Singer	X	X	
Hydropus scabripes (Murrill) Singer	X	X	
Hygrocybe fornicata (Fr.) Singer		X	
Inocybe heimii Bon	X		
Inocybe leptophylla G. F. Atk.	X		
Lactarius violascens (J. Otto) Fr.		X	
Leccinellum corsicum (Rolland) Bresinsky & Manfr. Binder	X	X	
Leucopaxillus compactus (Fr.) Neuhoff	X	X	X
Lycoperdon decipiens Durieu & Mont.		X	
Lyophyllum tenebrosum Clemençon		X	
Macrothyphula fistulosa (Holmsk.) R.H. Petersen	X		
Marasmius alliaceus (Jacq.) Fr.	X		
Mycena alba (Bres.) Kühner		X	
Mycena algeriensis Maire	X		
Mycena olivaceomarginata (Massee) Massee	X		
Mycena xantholeuca Kühner		X	
Omphalina pyxidata (Bull.) Quél.	X		
Phaeomarasmius erinaceus (Fr.) Scherff. ex Romagn.	X		
Phellodon confluens (Pers.) Pouzar		X	
Pluteus thomsonii (Berk. & Broome) Dennis	X		
Ramaria aurea (Schaeff.) Quél.		X	
Ramaria fennica (P. Karst.) Ricken		X	
Ramaria flavescens (Schaeff.) R.H. Petersen		X	
Ramaria formosa (Pers.) Quél.		X	
Russula emetica (Schaeff.) Pers.	X		
Sarcodon cyrneus Maas Geest.	X	X	
Steccherinum bourdotii Saliba & A. David		X	
Tricholoma bresadolanum Clemençon	X		
Tricholoma roseoacerbum A. Riva		X	
Tricholoma sulphurescens Bres.	X	X	
Xerula melanotricha Dörfelt		X	

Tab. 1 - Macrofungal species reported in the Tuscan Red list (T), listed as candidates for a future European Red list (ERL) and proposed for inclusion in the Bern Convention Appendix (BC).

were made in Italy and also for Tuscany it is a data deficient (DD) species. Two others macrofungi relevant for assessment for the future European Red list are *Dendrocollybia racemosa* which grows in forests, on remains of plants, on mosses and on partially decomposed mushrooms (Breitenbach, 1991) and is considered as "Vulnerable" (VU) in the Tuscan Red List (Antonini & Antonini, 2006) and *Leccinum corsicum* which is a typical mediterranean species, strictly associated with *Cistus* spp. (Galli, 1998) and considered VU in Turkey (http://www.wsl.ch/eccf) and "Near Threatened" (NT) in Tuscany (Antonini & Antonini, 2006). *Tricholoma sulphurescens*, *Hydnellum peckii* and *Sarcodon cyrneus* are listed as "Least Concern" (LC) in Tuscany; the first species, typical of xerophilous hardwoods forests, is also

included in the Red List of France (http://www.wsl.ch/eccf) whereas *H. peckii* which grows under coniferous forest and *S. cyrneus* which is connected with mediterranean woods, especially under *Quercus ilex*, are listed in Spain and Portugal (Antonini & Antonini, 2006). Among the genus *Cortinarius*, *C. prasinus*, *C. suaveolens* and *C. aleuriosmus,* are included in the Red list of Tuscany as "Data Deficient" (DD), together with *Entoloma corvinum*, *E. mougeotii*, *Hydropus floccipes* and *H. scabripes* (Antonini & Antonini, 2006). All these species are considered in various European Red Lists, among them France where a small part of the South is considered in the Mediterranean biogeographical zone.

Among the others 19 species listed as candidates for a future European Red Lists, but not cited in Tuscany, 6 mycetes results threatened in Mediterranean countries (Croatia, Spain, Portugal and Turkey) whereas 13 *taxa* are predominantly included in Red Lists of Northern-Central Europe (Tab. 1).

Among the species reported, 28 macrofungi are considered in different status of threat, but only in Tuscany (Tab. 1). Among these, 22 needs more informations and are classified as "Data Deficient" (DD) and four species *Cortinarius bolaris*, *Entoloma incanum*, *Inocybe heimii* and *Omphalina pyxidata* are listed as "least concern" (LC). The last two species are of pivotal conservation interest since they predominantly grow on sabulicolous soil, in coastal areas, on dune that represent a very threatened habitat (Stangl, 1991; Courtecuisse, 1994). The sporadic presence of these species in sabulicolous forests far from the littoral zone, such as "Montagnola Senese", doesn't reduce their risk of extinction. *Inocybe leptophylla* which grows in coniferous forests on woody debris or on rotten stumps (Stangl, 1991) and *Mycena algeriensis* a saprotroph on remains of wood typical of Mediterranean forests, especially of *Quercus ilex* and *Q. suber* (Robich, 2003), are considered as "Not Threatened" (NT) in Tuscany .

Due to taxonomic problems *Hygrocybe olivaceonigra*, even if observed in the studied area and considered as Endangered (EN) in the Tuscan Red List, is not included in the list of threatened species (Tab. 1). In fact this species, in the past a distinct entity, according to some authors is considered a sub-specific *taxon* of *H. conica* (*H. conica* var. *olivaceonigra*). At present however all subspecies and varieties of *H. conica* are gathered in only one common species and *H. olivaceonigra* becomes an invalid *taxon*. Reviews and changing are very frequent in mycology and this partially explain the problem of considering organisms not well defined from a taxonomic point of view.

On the basis of criterion B, the area results to present a good mycodiversity with more than 500 epigeous macromycetes. According to the surveys done in the United Kingdom an area presenting such diversity in fungal species can be considered among this criteria (Evans et al, 2002). This is also confirmed comparing the "Montagnola Senese" with other areas of central southern Tuscany investigated from a mycological point of view over a longer period, considering coenological researches and floristic excursions. In fact in the hardwoods dominated by *Quercus cerris*, of the Natural Reserve Berignone-Tatti, 447 macromycetes were listed (Leonardi et al, 2010) while in mixed forests principally characterized by *Fagus sylvatica, Quercus cerris* and *Abies alba* forests in the Pigelleto Natural Reserve (Monte Amiata) 426 species are reported (Pecoraro *et al*., 2007).

Concluding, the interesting area of the "Montagnola Senese", a puzzle given by castles, ancient villages, some fields and rich in woods, just recognized as a site deserving conservation for various reasons, can on hand of this analysis also be selected as an Important Mycological Area because of the presence of fungal species of conservation concern and the exceptionally rich mycoflora.

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