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Dedicated to Professor Alina Skirgiełło on the occasion of her ninety-fifth birthday

Mycodiversity of Nature Reserves in Central Italy

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Seven nature reserves situated in the province of Arezzo (Tuscany, Central Italy), presenting various habitats, plants and animals of comunitary interest according to the Habitat Directive, have been observed from a myco-floristic viewpoint. A synthesis of the results on fungal investigations is given. Interesting the finding of rare species such as *Ramariopsis pulchella* and *Mycena diosma*.

Key words: macromycetes, mycodiversity, nature reserve, habitat directive, Tuscany

INTRODUCTION

Article 2. of the Convention on Biological Diversity (CBD) defines biological diversity as "the variability among living organisms from all sources including, *inter alia*, terrestrial, marine and other aquatic ecosystems and the ecological complexes of which they are part; this includes diversity within species, between species and of ecosystems".

The slow decline of biological diversity on our planet began approximately 10,000 years ago and has accelerated in the last century: due to human activities, the rate at which species disappear has increased from 100 to 1,000 times the rate of natural extinction. Various international organisations have been working on the monitoring and conservation of genetic resources on a planetary scale for many years, benefiting from the support of the FAO at various levels. Macromycetes, sad to say, have been excluded from all these protection schemes: in Italy, for example, there is no specific law for their protection, except for regulations on the picking and selling of edible species.

In this context, we report a synthesis of the results of investigations into the mycofloristic composition of seven Nature Reserves in the Province of Arezzo (Laganà et al. 2003, 2004; Perini et al. 2003; Salerni et al. 2000a). The scientific community's level of interest in these areas is demonstrated by the numerous

floristic-vegetational and faunistic studies undertaken in recent years, with the aim of improving knowledge of their animal and vegetable heritage and proposing management measures for their conservation, protection and restoration. Of particular interest and some of priority interest according to the HABITAT directive no. 92/43/CEE are unusual habitats such as the humid zones (Valle dell'Inferno e Bandella; Ponte a Buriano e Penna), rocky ophiolitic environments (Monti Rognosi), mixed *Tilio-Acerion* forests (Bosco di Montalto), the pioneer grassland vegetation of rocky zones (Alpe della Luna), and at a specific level, both animals (wolf, golden eagle, goshawk, *Rosalia alpina*) and plants (*Taxus baccata*) can be found. The provincial administration strongly encouraged the inclusion of the mycological component in this study, demonstrating a particularly well developed "ecologic conscience" and a sensitivity towards such issues and these organisms in particular that is far-sighted to say the least.

MATERIAL AND METHODS

The results reported refer to myco-floristic observation carried out in the seven Nature Reserves situated in the Province of Arezzo between 1998 and 2002 (Fig. 1). The study was carried out through on-the-spot investigations in autumn (September-November), when the meteorological conditions were deemed optimum for the growth of fruiting bodies (indispensable for recognising the species), and

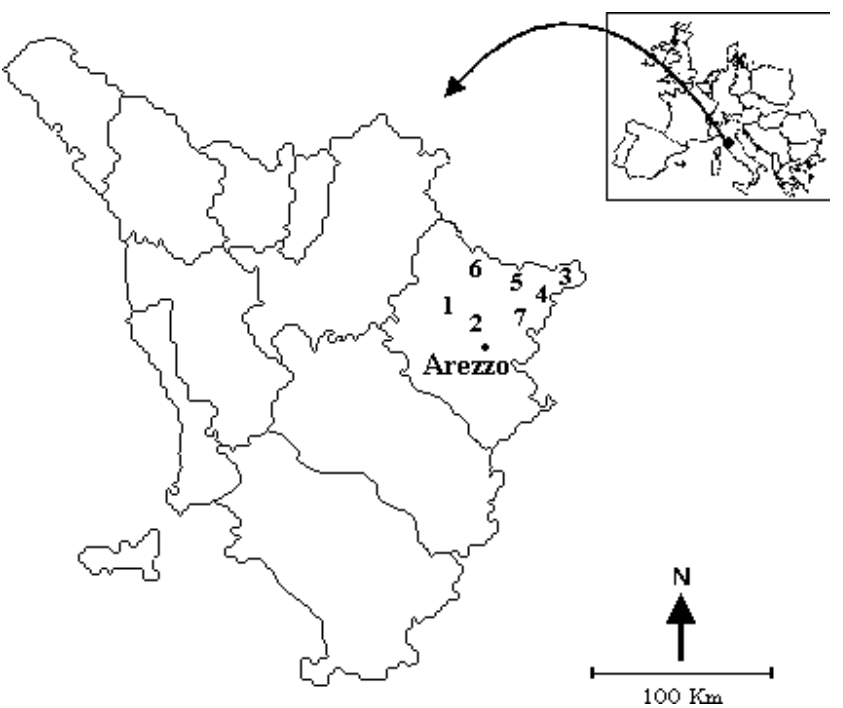

Fig. 1. Map of the study areas.
1 – Valle dell'Inferno e Bandella; 2 – Ponte a Buriano e Penna; 3 – Sasso di Simone; 4 – Alpe della Luna; 5 – Montalto; 6 – Alta Valle del Tevere; 7 – Monti Rognosi.

sporadically in springtime. We recorded all epigeous macromycetes found in the main types of vegetation or particular habitats present in the Reserves; samples were often picked for examination under the laboratory microscope in order to check or confirm correct identification.

Species nomenclature followed that of the Dutch check-list (Arnolds et al. 1995) taxa not in this list were according to various texts and monographs (Breitenbach, Kranzlin 1981–2000; Moser 1983; Riva 1988; Stangl 1991; Antonìn, Noordeloos 1993; Courtecuisse, Duhem 1994; Bon 1997; Sarnari 1998; Consiglio, Contu 2002). Species authorities were abbreviated according to Brummitt, Powell (1992). The species picked were dried and conserved in the *Herbarium Universitatis Senensis* (SIENA). For the majority of taxa an abundance value according to Jahn et al. (1967) is given: **r** (rarus) – species occuring in single exemplares in a amall quantity, **n** (numerus) – species widespread on the area, single or in several exemplars, **a** (abundans) – species common on the area in great number of exemplars.

AREA OF INVESTIGATIONS

Ponte a Buriano e Penna and Valle dell'Inferno e Bandella. These two Nature Reserves are situated the Western part of the town Arezzo (Fig. 1, area 1 and 2) and runs along the middle course of the Arno river. According to the Thornthwaite classification (1948), the climate is moist subhumid (class C2: MI between 0 and 19.9). From a lithological viewpoint, the area is characterised by fluvio-lacustrine sediments from various periods, fluvial and marsh deposits.

The Ponte a Buriano e Penna Nature Reserve (668 ha) at an altitude between 200 and 260m, runs along the river Arno for approximately 7km, beginning slightly upstream of its confluence with the canal Maestro della Chiana and continuing across the Arezzo plain as far as the Penna dam. The forest vegetation mainly comprises oak woods of *Quercus pubescens*, as well as other arboreal species such as *Q. ilex*, *Q. cerris*, *Fraxinus ornus*, *Ostrya carpinifolia* and many shrubs (*Crataegus monogyna*, *Ligustrum vulgare*, *Spartium junceum,* etc.) and grasses (*Cyclamen* spp., *Viola* spp., *Orchis* spp., etc.). There are strips of riparian vegetation characterised by poplars, especially black poplars (*Populus nigra*), *Salix* spp., *Ulmus minor* and *Robinia pseudoacacia* along the ditches, gullies and tributaries, and a wide area of marsh vegetation at the confluence of the canal Maestro della Chiana with the Arno, composed of vast stands of common reeds (*Phragmites australis* and smaller areas where rushes (*Juncus* spp.), sedges (*Carex* spp.), yellow irises (*Iris pseudacorus*) can be found (Viciani 1997).

The Reserve Valle dell'Inferno e Bandella (531 ha) runs along the Arno river for approximately 4km, between 180 and 220 m a.s.l.. The deciduos oak woods are mainly composed of *Quercus cerris* woods that also sporadically host other species (*Q. robur, Q. pubescens*). Hygrophilous riparian vegetation is equally important, comprising *Salix* spp., *Populus* spp., *Alnus glutinosa*, *Corylus avellana* and *Carpinus betulus* growing along the banks of the river Arno and its tributaries. A strip of marsh vegetation has formed in the Bandella loop in particular, composed of *Juncus articulatus, J. effusus, J. conglomeratus*, *Nymphaea alba* and *Phragmites australis* (Raffaelli 1997).

Monti Rognosi. The area lies on ophiolites formed by ultramafic igneous rocks (Pichi Sermolli 1948), a lithology not so common in Tuscan areas. The Reserve covers a total of 156 ha and is located in the upper basin of the river Tevere, North from Arezzo (Fig.1, area 7). It is characterised by quite steep slopes with visible large rocky outcrops and the altitude varies between 370 and 630m a.s.l..

The climate is mesothermal suboceanic, from humid to subhumid, with a moderate summer deficit (Bigi, Rustici 1984). Local factors, such as the dark green colour of the rocks, the lack of soil accumulation and the scarcity of vegetation, may contribute to accentuating the dryness and higher temperatures that characterise the summer months (De Dominicis et al. 2001a).

The phytogeographic aspect of the area studied is important (De Dominicis et al. l.c.) as types of vegetation typical of open areas and well adapted to the relatively inhospitable climate and soil can still be found, despite over seventy years of intense reforestation. The pinewoods planted (*Pinus nigra, P. pinaster*) since the 1930's on former garigues are generally quite extensive and currently occupy almost 50% of the surface area. The serpentine vegetation is generally confined to steeply sloping zones and rocky outcrops. The garigues have very discontinuous vegetation cover, with large outcrops of bare rock. Although limited in area, the steppe grasslands represent very unusual coenoses, with some species of significant conservational interest, such as *Stipa tirsa, S. etrusca* and *Chrysopogon grillus*. Semi-mesophilous shrubberies of *Rosa canina, Prunus spinosa, Cornus sanguinea, Crataegus monogyna,* occasional *Juniperus communis* and/or *J. oxycedrus* and locally abundant *Spartium junceum* are more common. Where the pines have not reached, there are mixed woods of turkey oak and European hop hornbeam on the cooler slopes of ophiolite outcrops and downy oak woods in drier and warmer areas.

Alta Valle del Tevere (Monte Nero). This Regional Nature Reserve, at the Northern border of Tuscany (Fig. 1, area 6), covers an area of 470 ha at an altitude of between 740 m and 1240 m a.s.l. and most of the reserve has gradients of over 50%. The climate can be described as mesothermal suboceanic, humid with a slight summer deficit (Bigi, Rustici 1984). From a lithologic point of view, most of the area is located on the marly-arenaceous Romagna formation; there is also a strip of Macigno, marls, and an undifferentiated complex prevalently composed of clay schists and marly limestones at Monte Castelsavino.

The area has quite a good variety of vegetation. Between 700 and 1000 m there are grasslands and shrubberies that originated from the change of use from former agricultural or pastoral land. These limited formations are then replaced by coppices, transitory high forests and conifer plantations. Mixed mesophilous montane woods can be found in scattered formation at the same range of altitude, with a prevalence of *Acer* spp. and *Tilia* spp., while the woods in higher zones are clearly dominated by *Fagus sylvatica* L. Neutrophilous mountain woods are quite common in this Reserve, formed of *Quercus cerris* mixed with *Ostrya carpinifolia* and *Acer opalus*, accompanied by *Fraxinus ornus, Q. pubescens, Sorbus aria* and occasionally *Carpinus betulus, A. campestre* and *Prunus avium* (De Dominicis et al 2001b).

Sasso di Simone. This Reserve lies on the Apennines in North Eastern part of Tuscany, bordering with the region Emilia Romagna and Marche (Fig.1, area 4). From a lithological point of view, this Reserve (1604 ha, 940 – 1221 m a.s.l.) has

three main lithotypes: organogenic calcarenites and marly limestones, chaotic flaky clays and marly-arenaceous Flysch. According to the Thornthwaite (1948) classification, the climate in this area is humid (class B3, MI between 40 and 60).

The forest vegetation is primarily composed of *Quercus cerris* woods associated with *Carpinus betulus* in some places. The forest landscape at the base of the rocky part of the north-facing slope is characterised by mixed woods with a prevalence of *Fagus sylvatica* and the presence of *Tilia platyphyllos*, *Fraxinus excelsior*, *Acer pseudoplatanus* and *Acer platanoides*. The open areas near the "Sasso di Simone" rock are composed of grassland used for grazing cattle (Gonnelli 1997).

Alpe della Luna and Bosco di Montalto. These two Nature Reserves are located between Alta Valle del Tevere and Sasso Simone (Fig.1, area 4 and 5), a little bit Southern. The climate can generally be described as mesothermal sub-oceanic: humid with a slight summer deficit (Bigi, Rustici 1984). In the two Reserves *Taxus baccata* trees can be found. From a vegetational point of view, both areas are of significant phytogeographic interest due to the presence of nuclei of mixed mesophilous montane woods composed of maples, linden and common ash and a few yew trees belonging to the *Tilio-Acerion* alliance (De Dominicis et al. 2001c,d).

Alpe della Luna covers a total of 1540 ha at an altitude between 600 m at the northern and southern boundaries and 1453 m on the highest ridge. From a geological point of view, the area is characterised by the meeting at the lowest altitude of the Macigno del Mugello, mainly composed of siliceous sandstones with marls and silty schists, with the marly-arenaceous Romagna formation, which is composed of sandstones and marls. The Reserve is mainly characterised by coppices and transitory high forests of broad-leaved trees. The woods on the Tyrrhenian slopes have a clear prevalence of beech with *Cardamine enneaphyllos* and at a lower altitude the beech is accompanied by other woody species such as *Crataegus monogyna*, *Laburnum alpinum, Quercus cerris* and *Sorbus aria*; we should also highlight the presence not only of *Taxus baccata* but also of nuclei of *Ilex aquifolium.* Pioneer grasslands grow on both slopes in areas affected by erosion, while the valley floor is home to gorge woods with a prevalence of *Carpinus betulus*, accompanied by beeches, lindens, maples and hazels (De Dominicis et al. 2001c).

The Bosco di Montalto Reserve occupies a small area (22ha) at an altitude of between 875m and 1061m a.s.l.. The lithology of the area is characterised by the meeting of two geological formations: "alberese", constituted of calcareous and marly-calcareous sediments, and the "Sillano unit", composed of argillites with lithoid masses of "alberese" and "pietraforte" sandstones (Bini et al. 1982).

Most of the reserve's surface area is covered by thermophilous and meso-hygrophilous beech woods, mainly composed of beeches, turkey oaks and European hop-hornbeam; the presence of *Tilia platyphyllos, Fraxinus exelsior* and, although sporadic, of *Acer pseudplatanus*, is also significant. Meso-hygrophilous montane woods with turkey oaks and European hornbeam can be found at lower altitudes and on the Sillano argillites, with the sporadic presence of *Taxus baccata* (De Dominicis et al. 2001d).

RESULTS AND DISCUSSION

The seven protected areas observed, with particular emphasis to the interesting habitats, generally show a good mycodiversity (Tab. 1) and the presence of fungal

Table 1
Macrofungal species found in the 7 Nature Reserves (Arezzo, Italy)

1 – Valle dell'Inferno e Bandella; **2** – Ponte a Buriano e Penna; **3** – Sasso di Simone; **4** – Alpe della Luna; **5** – Montalto; **6** – Alta Valle del Tevere; **7** – Monti Rognosi

SPECIES	1	2	3	4	5	6	7
Agaricus arvensis Schaeff. : Fr.				n			
Agaricus bitorquis (Quél.) Sacc.				r			
Agaricus campester L. : Fr.			n	n			
Agaricus comtulus Fr.						r	
Agaricus phaeolepidotus (F.H. Moeller) F.H. Moeller	r						
Agaricus porphyrizon P.D.Orton	r						
Agaricus praeclaresquamosus Freeman	n						
Agaricus silvicola (Vittad.) Sacc.	n			r			
Amanita battarrae (Boud.) Bon				r			
Amanita citrina (Schaeff.) Pers. F. *alba* (S. Price) Quél.						n	
Amanita citrina (Schaeff.) Pers.	a	a		a		r	
Amanita mairei Foley							r
Amanita pantherina (DC.: Fr.) Krombh.	r	n		r		n	
Amanita phalloides (Fr.: Fr.) Link	n	n		n		n	
Amanita rubescens Pers.: Fr.	n	r		a		n	
Amanita vaginata (Bull.: Fr.) Lam. ss. str.	*	*		a		n	n
Armillaria mellea s.l.	*	*	*	*		*	
Armillaria ostoyae (Romagn.) Herink				r			
Armillaria tabescens (Scop. : Fr.) Emel.				*			
Astraeus hygrometricus (Pers. : Pers.) Morgan				r			
Bisporella citrina (Batsch) Korf & S.E. Carp.				n			
Boletus chrysentheron (Bull.) ss. str.	n	n		n			
Boletus impolitus Fr.				*		*	
Boletus queletii Schulzer	*			*			
Boletus rubellus Krombh. ss. str.	*						
Boletus subtomentosus L.: Fr.	n	n					n
Calocybe gambosa (Fr. : Fr.) Singer				*			
Calvatia excipuliformis (Scop. : Pers.) Kreisel				r		r	r
Cantharellus cibarius Fr.: Fr.	*						
Chroogomphus fulmineus (R. Heim) Courtec.							n
Chroogomphus rutilus (Schaeff. : Fr.) O.K. Mill.							a
Clathrus ruber Pers. : Pers.							r
Clavaria fragilis Holmsk.: Fr.	r	r		r			
Clavariadelphus pistillaris (Fr.: Fr.) Donk	n			*			
Clavariadelphus truncatus (Quél.) Donk	r						
Clavulina coralloides (L. : Fr.) J. Schröt.				a			
Clavulina rugosa (Bull. : Fr.) J. Schröt.				r			
Clitocybe alexandri (Gillet) Gillet	*						
Clitocybe candicans (Pers. : Fr.) P. Kumm.				*		*	
Clitocybe costata Kühner & Romagn.				*		*	
Clitocybe fragrans (With. : Fr.) P. Kumm.				*			*
Clitocybe gibba (Pers.: Fr.) P. Kumm.	*	*		a	n	*	
Clitocybe inornata (Sowerby : Fr.) Gillet				*			
Clitocybe metachroides Harmaja						*	
Clitocybe nebularis (Batsch: Fr.) P. Kumm.			n	a	n	a	
Clitocybe obsoleta (Batsch : Fr.) Quél.						*	

Tab. 1 cont.

SPECIES	1	2	3	4	5	6	7
Clitocybe odora (Bull. : Fr.) P. Kumm.				n		r	
Clitocybe phaeophthalma (Pers.) Kuyper	n			n		n	
Clitocybe phyllophila (Pers. : Fr.) P. Kumm.					*	*	
Clitocybe rivulosa (Pers. : Fr.) P. Kumm.				r			
Clitocybe subspadicea (J.E. Lange) Bon & Chevassut				*			
Clitopilus prunulus (Scop. : Fr.) P. Kumm.				a		*	
Collybia butyracea (Bull.: Fr.) P. Kumm.	*	*	*	a		n	
Collybia butyracea (Bull.: Fr.) P. Kumm. var. *asema* (Fr.: Fr.) Quél.				r			
Collybia confluens (Pers. : Fr.) P. Kumm.				*			
Collybia cookei (Bres.) J. D. Arnold				*			
Collybia dryophila s.l.			*	a	*	n	*
Collybia erythropus (Pers.: Fr.) P. Kumm.	*			r		*	
Collybia fusipes (Bull.: Fr.) Quél.	*						
Collybia hariolorum (Bull. : Fr.) Quél.				*	n		
Collybia peronata (Bolton : Fr.) P. Kumm.				n	*	*	
Coprinus comatus (O. F. Müll.: Fr.) Pers.	*			n			
Coprinus micaceus (Bull. : Fr.) Fr.				n			
Cortinarius aleuriosmus Maire	*						
Cortinarius allutus Fr.						*	
Cortinarius anomalus (Fr.: Fr.) Fr. ss. str.	*			*		n	
Cortinarius anserinus (Velen.) Rob. Henry						*	
Cortinarius aprinus Melot	*	*		n		n	
Cortinarius auroturbinatus (Secr.) Lange				r			
Cortinarius bicolor Cooke						*	
Cortinarius bulliardi (Pers.: Fr.) Fr.	*			*	n	*	
Cortinarius calochrous (Pers.: Fr.) Fr.	n			n	n	n	
Cortinarius calochrous (Pers. : Fr.) Fr. var. *carolii* (Velen) Nezdjm.						*	
Cortinarius coerulescens (Schaeff.) Fr.				r	*	n	
Cortinarius conicus (Velen.) Rob. Henry				*			
Cortinarius cotoneus Fr.				*	n	*	
Cortinarius delibutus Fr.						*	
Cortinarius dionysae Rob. Henry			*				
Cortinarius diosmus Kühner				*		*	
Cortinarius duracinus Fr.	*	*	*	n		n	n
Cortinarius glaucopus (Schaeff. : Fr.) Fr.				*		*	
Cortinarius glaucopus (Schaeff. : Fr.) Fr. var. *olivaceus* (M.M. Moser) Quadr.						*	
Cortinarius hillieri Rob. Henry				r			
Cortinarius hinnuleus Fr. ss.str.			*	*			
Cortinarius hinnuloides Rob. Henry	*	*					
Cortinarius infractus (Pers.: Fr.) Fr.	*		*	*		*	
Cortinarius largus Fr.						*	
Cortinarius lividoochraceus (Berk.) Berk.	n	n			a		
Cortinarius nanceiensis Maire					n		
Cortinarius olivaceofuscus Kühn.	*						
Cortinarius paleaceus Fr. ss. Str.	n	n		n		n	
Cortinarius prasinus (Schaeff.) Fr.						*	
Cortinarius rapaceus Fr.				*			
Cortinarius rufoolivaceus (Pers. : Fr.) Fr.				*		n	
Cortinarius safranopes Rob. Henry	n						
Cortinarius salor Fr.						n	
Cortinarius splendens Rob. Henry			*				
Cortinarius torvus (Bull.: Fr.) Fr.	*		*	*		*	
Cortinarius trivialis J. E. Lange	*	*	*	n	a	n	
Craterellus cornucopioides (L.: Fr.) Pers.	a	a		a			
Craterellus lutescens (Pers. : Fr.) Fr.							*
Entoloma ameides (Berk. & Broome) Sacc.				r			

Tab. 1 cont.

SPECIES	1	2	3	4	5	6	7
Entoloma hebes (Romagn.) Trimbach	*						
Entoloma lividoalbum (Kühner & Romagn.) Kubicka	*						
Entoloma rhodopolium (Fr.: Fr.) P. Kumm.	r	r		n		n	r
Entoloma rhodopolium (Fr. : Fr.) P. Kumm. f. *nidorosum* (Fr.) Noordel.				n			
Entoloma scabrosum (Fr.) Noordel.						*	
Entoloma sericatum (Britzelm.) Sacc.	*						
Entoloma sericellum (Fr. : Fr.) P. Kumm.				*		*	
Entoloma serrulatum (Fr. : Fr.) Hesler							*
Entoloma sinuatum (Bull. ex Pers.: Fr.) P. Kumm.	*	*					
Flammulaster carpophilus (Fr.) Earle	r		r				r
Ganoderma australe (Fr.) Pat.		r					
Ganoderma lipsiense (Batsch) J.F.Atk.			r				
Ganoderma lucidum (M. A. Curtis: Fr.) P. Karst.			r				
Hebeloma crustuliniforme (Bull.) Quél. ss. str.			*			n	
Hebeloma mesophaeum (Pers.) Quél.	n					*	
Hebeloma sacchariolens Quél. ss. str.	*			*		*	
Hebeloma senescens (Batsch) Berk. & Broome				*			
Hebeloma sinapizans (Fr.) Gillet	*	*	*	n	a	n	*
Helvella crispa (Scop.) Fr.				*	n	*	
Helvella elastica Bull.				*			
Helvella lacunosa Afzel.				r	*	*	
Hemimycena cucullata (Pers.: Fr.) Singer	*	*		*			n
Hemimycena lactea (Pers. : Fr.) Singer					*	*	
Hohenbuehelia petaloides (Bull.: Fr.) S. Schulz.	r						
Humaria hemisphaerica (F.H. Wigg.) Fuckel						r	
Hydnum repandum L.: Fr.	*			*			
Hydnum rufescens Fr.: Fr.			*	*		*	
Hygrocybe acutoconica (Clemençon) Singer	*						n
Hygrocybe conica (Schaeff.: Fr.) P. Kumm.	*			*			
Hygrocybe conica (Schaeff. : Fr.) P. Kumm. var. *cloroides* (Malençon) Bon				*			
Hygrocybe conica (Schaeff. : Fr.) P. Kumm. f. *pseudoconica* (J. Lange) Arnolds				*			
Hygrocybe conicoides (P.D.Orton) Orton & Watling	n						
Hygrocybe pratensis (Pers. : Fr.) Murrill				*			
Hygrocybe psittacina (Schaeff. : Fr.) P. Kumm.				*			
Hygrocybe russocoriacea (Berk. & Mill.) P.D. Orton & Watling				r			
Hygrocybe virginea (Wulfen: Fr.) P. D. Orton & Watling	n			*		*	
Hygrophoropsis aurantiaca (Wulfen : Fr.) Maire							*
Hygrophorus arbustivus (Fr.) Fr.				*	n		
Hygrophorus chrysodon (Batsch : Fr.) Fr.				*			
Hygrophorus cossus (Sowerby) Fr.				a	*	*	
Hygrophorus discoxanthus (Fr.) Rea	*	*	*		a		
Hygrophorus eburneus (Bull. : Fr.) Fr.				*	a		
Hygrophorus lindtneri M. M. Moser	*		*	*			
Hygrophorus penarius Fr.						*	
Hygrophorus persoonii Arnolds						n	
Hygrophorus persoonii Arnolds var. *fuscovinosus* (Bon) Bon	*	*	n				
Hygrophorus roseodiscoideus Bon & Chevass.			*				
Hygrophorus russula (Fr.: Fr.) Quél.			*	*		*	
Hymenoscyphus calyculus (Sowerby) W. Phillips				*			
Inocybe adaequata (Britzhelm.) Sacc.	r						
Inocybe asterospora Quél.	*			*			
Inocybe bongardii (Weinm.) Quél.	*			n	n	*	
Inocybe bongardii (Weinm.) Quél. var. *pisciodora* (Donadini & Riousset) Kuyper				*			
Inocybe brevicystis Métrod ex Kuyper				*			

Tab. 1 cont.

SPECIES	1	2	3	4	5	6	7
Inocybe cervicolor (Pers.) Quél.				*		*	
Inocybe flocculosa Sacc.				n			
Inocybe fraudans (Britzelm.) Sacc.	*			*		*	
Inocybe fuscidula Velen.	*	*					
Inocybe geophylla (Fr. : Fr.) P. Kumm.				a	a	a	
Inocybe geophylla (Fr. : Fr.) P. Kumm. var. *lilacina* (Peck) Gillet				n			
Inocybe obscurobadia (J. Favre) Grund & D.E. Stuntz				n			
Inocybe phaeocomis (Pers.) Kuyper				r			
Inocybe rimosa (Bull.: Fr.) P. Kumm.	*				*	*	
Inocybe sindonia (Fr.) P. Karst.				*			
Inocybe splendens R. Heim				*			
Inocybe splendens R. Heim var. *phaeoleuca* (Kühner) Kuyper				*			
Inocybe tenebrosa Quél.				n			
Inocybe terrigena (Fr.) Kuyper				*			
Laccaria amethystina Cooke						*	
Laccaria laccata s. l.	*	*		*		n	n
Laccaria laccata (Scop. : Fr.) Cooke var. *pallidifolia* (Peck) Peck				*			
Laccaria proxima (Boud.) Pat.							*
Lactarius acerrimus Britzelm.							*
Lactarius azonites (Bull.) Fr.				*			
Lactarius blennius (Fr. : Fr.) Fr.				n	*	*	
Lactarius camphoratus (Bull. : Fr.) Fr.						*	
Lactarius chrysorrheus Fr.	n	n	n	n		a	n
Lactarius cimicarius (Batsch) Gillet				n		n	
Lactarius decipiens Quél.	*						
Lactarius deliciosus (L.: Fr.) Gray	*						n
Lactarius ichoratus (Batsch) Fr.						*	
Lactarius insulsus (Fr.: Fr.) Fr.	*		*				
Lactarius pallidus Pers. : Fr.				*			
Lactarius quietus (Fr.:Fr.) Fr.	*	*					
Lactarius semisanguifluus R. Heim & Leclair							n
Lactarius serifluus (D.C.:Fr.) Fr.	*	*		*	*		
Lactarius uvidus (Fr. : Fr.) Fr.				*			
Lactarius vellereus (Fr. : Fr.) Fr.				*		*	
Lactarius zonarius (Bull.) Fr.				*			
Leotia lubrica (Scop.) Pers.				*			
Lepiota aspera (Pers.:Fr.) Quél.	r						
Lepiota castanea Quél.	*						
Lepiota clypeolaria (Bull.: Fr.) P. Kumm.	*	*	*	*	a	n	
Lepiota cristata (Alb. & Schwein.:Fr.) P.Kumm.	*			*	*		
Lepista flaccida (J. Sowerby: Fr.) Pat.	*	*		*			
Lepista nuda (Fr.: Fr.) Cooke			*	*	a	n	
Lepista sordida (Fr. : Fr.) Singer						*	
Leucoagaricus leucothites (Vittad.) Wasser							*
Leucopaxillus gentianeus (Quél.) Kotl.	*	*					
Lycoperdon echinatum Pers. : Pers.					n		
Lycoperdon perlatum Pers.: Pers.	*	*		*	*	a	n
Lycoperdon pyriforme Schaeff. : Pers.				*			
Lyophyllum deliberatum (Britzelm.) Kreise				*			
Lyophyllum transforme (Britzelm.) Singer				*		*	
Macrolepiota excoriata (Schaeff.:Fr.) Wasser			*				
Macrolepiota procera (Scop.: Fr.) Singer	*					*	*
Marasmius alliaceus (Jacq.: Fr.) Fr.			*	*			
Marasmius cohaerens (Pers. : Fr.) Cooke & Quél.				*		*	
Marasmius epiphyllus (Pers. : Fr.) Fr.				*	*		
Marasmius oreades (Bolt.:Fr.) Fr.	n		*	*			
Marasmius torquescens Quél.				*		*	

Tab. 1 cont.

SPECIES	1	2	3	4	5	6	7
Marasmius wynnei Berk. & Broome				*			
Megacollybia platyphylla (Pers. : Fr.) Kotl. & Pouzar						*	
Melanoleuca melaleuca (Pers. : Fr.) Murrill					*		
Micromphale brassicolens (Romagn.) P.D. Orton				*	a		
Mutinus caninus (Huds. : Pers.) Fr.				r			
Mycena acicula (Schaeff. : Fr.) P. Kumm.				r			
Mycena alba (Bres.) Kühner				*			
Mycena capillaripes Peck						*	
Mycena diosma Krieglst. & Schwöbel				r	n	r	r
Mycena epipterygia (Scop. : Fr.) Gray				*		*	
Mycena galericulata (Scop.: Fr.) Gray	*	*		*			
Mycena galopus (Pers.: Fr.) P. Kumm.	n	n		*		*	
Mycena maculata P. Karst.			*				
Mycena meliigena (Berk. & Cooke) Sacc.			*				
Mycena pelianthina (Fr.: Fr.) Quél.	*			a	a	n	n
Mycena polygramma (Bull.: Fr.) Gray	r		r		r	r	
Mycena pura (Pers. : Fr.) P. Kumm. f. *alba* (Gillet) Kühner				*		*	
Mycena pura (Pers.: Fr.) P. Kumm.	n	n		a	a	n	n
Mycena rosea (Bull.) Gramberg	*	*	*	*	a	n	n
Mycena vitilis (Fr.) Quél.	n	n		n		n	
Omphalotus olearius (DC.: Fr.) Singer	*						
Otidea alutacea (Pers.) Massee	r						
Otidea bufonia (Pers.) Boud.	r						
Panaeolus fimicola (Fr. : Fr.) Quél.						r	
Panellus stipticus (Bull.: Fr.) P. Karst.			*	*		*	
Paxillus involutus (Batsch : Fr.) Fr.				*			n
Phaeomarasmius erinaceus (Fr.: Fr.) Singer			*				
Pholiota lucifera (Lasch) Quél.	r						
Pleurotus ostreatus (Jacq. : Fr.) P. Kumm.				*			
Pluteus nanus (Pers. : Fr.) P. Kumm.						r	
Pluteus thomsonii (Berk. & Broome) Dennis						r	
Podophacidium xanthoneum (Pers.: Fr.) Kavina				r			
Polyporus varius Fr.				r		r	
Psathyrella candolleana (Fr. : Fr.) Maire							n
Psathyrella tephrophylla (Romagn.) Bon	r						
Psilocybe aeruginosa (M.A. Curtis : Fr.) Noordel.				*	*	*	
Psilocybe fascicularis (Huds.: Fr.) Noordel.	n		n	*		*	
Psilocybe sublateritia Fr.	n			*		n	
Ramaria flava (Schaeff. : Fr.) Quél.						n	
Ramaria stricta (Pers.:Fr.) Quél.	n					*	
Ramariopsis pulchella (Boud.) Corner	r						
Rhodocybe gemina (Fr.) Kuyper & Noordel.				*			
Rhodocybe parilis (Fr. : Fr.) Singer					n		
Russula acrifolia Romagn.						r	
Russula amoenolens Romagn.	r			r			
Russula aurea Pers.				n			
Russula cessans A. Pearson							r
Russula chloroides (Krombh.) Bres.	r	n	n	n		r	r
Russula cyanoxantha Schaeff.: Fr.	n	r		n			
Russula decipiens (Singer) Svrcek	*		*				
Russula densifolia Gillet						*	
Russula fellea (Fr. : Fr.) Fr.				r			
Russula foetens Pers.: Fr.	r			n		n	
Russula fragilis (Pers.: Fr.) Fr. ss. str.	n	n	a	a	a	n	
Russula heterophylla (Fr.: Fr.) Fr.	r						
Russula insignis Quél.	*						

Tab. 1 cont.

SPECIES	1	2	3	4	5	6	7
Russula luteotacta Rea				*			
Russula maculata Quél.	*			*			
Russula mairei Singer						*	
Russula persicina Krombh.	*	*	*	*		*	
Russula risigallina (Batsch) Sacc.	n	*		n		*	
Russula sanguinea (Bull.) Fr.							n
Russula torulosa Bres.							a
Russula vesca Fr.	*	*		*			
Russula vinosobrunnea (Bres.) Romagn.	*			*		*	
Russula xerampelina (Schaeff.) Fr.				*			
Suillus bellini (Inzenga) Kuntze							a
Suillus collinitus (Fr.) Kuntze							a
Suillus granulatus (L.: Fr.) Roussel	r						a
Trametes versicolor (L. : Fr.) Pilát						n	
Tricholoma acerbum (Bull.: Fr.) Quél.			*	*		*	
Tricholoma album (Schaeff.: Fr.) P. Kumm.	r		r	n	n	a	
Tricholoma atrosquamosum (Chev.) Sacc.			n	n	a	r	
Tricholoma basirubens (Bon) Riva & Bon			r				
Tricholoma fracticum (Britzelm.) Kreisel							n
Tricholoma lascivum (Fr. : Fr.) Gillet						r	
Tricholoma orirubens Quél.			n	n	n		
Tricholoma pessundatum (Fr. : Fr.) Quél.							*
Tricholoma saponaceum (Fr.: Fr.) P. Kumm.			n	*		*	
Tricholoma scalpturatum (Fr.) Quél.						*	
Tricholoma sejunctum (J. Sowerby: Fr.) Quél.	r	*	*	n		a	r
Tricholoma squarrulosum Bres.	*	*					
Tricholoma sulphureum (Bull.: Fr.) P. Kumm.	*	*		*	a	*	
Tricholoma terreum (Schaeff. : Fr.) P. Kumm.				*	*		
Tricholoma ustale (Fr.: Fr.) P. Kumm.	n		n	a	n	n	
Tricholoma ustaloides Romagn.				n		n	
Tubaria furfuracea (Pers.: Fr.) Gillet	*						
Tubaria hiemalis Bon						n	
Vascellum pratense (Pers.:Pers.) Kreisel			*				*
Xerocomus ichnusanus Alessio, R.Galli & Littini	r						
Xerocomus roseoalbidus Alessio & Littini	r						
Xerula pudens (Pers.) Singer	*			*			
Xerula radicata (Relhan: Fr.) Dörfelt	*		*	*	*	*	
Xylaria hypoxylon (L.: Fr.) Grev.			*	*		*	

species cited in several national and local Red Lists. Some of these are found rarely while other species are more common in some areas. No fungal species listed as threatened at a European level and proposed for inclusion in the Bern Convention were observed. For instance various larger fungi, red-listed in different European countries (Schembri, Sultana 1989; Arnolds et al. 1995; Bendiksen et al. 1997; Järva et al. 1998; Diamandis 2000; Gärdenfors 2000; Wojewoda, Ławrynowicz 2006), are frequent and abundant in the small "Bosco di Montalto" Nature Reserve. These are: *Collybia hariolorum, Cortinarius bulliardii, C. calochrous, C. cotoneus, C. lividoochraceous, C. nanceiensis, Hebeloma sinapizans, Helvella crispa*, *Hygrophorus arbustivus, H. discoxanthus, H. eburneus, Inocybe bongardii, Lycoperdon echinatum* with numerous carpophores*, Micromphale brassicolens, Mycena diosma, M. pelianthina, Rhodocybe parilis, Tricholoma atrosquamosum, T. orirubens, T. sulphureum, T. ustale*. If adequate information were available, these areas of the Prov-

ince of Arezzo could become important conservation sites in Europe for the more common fungi.

Many species found belong to a wide ecological range, growing in deciduous or coniferous woods on acidic, basic or neutral substrates, such as *Amanita phalloides, A. rubescens, A. vaginata* ss. str , *Laccaria laccata* s.l. and *Russula fragilis* ss. str. among the simbionts, or *Collybia butyracea*, *Lepiota clypeolaria*, *Mycena pelianthina*, *M. pura* and *M. rosea* among the saprotrophs.

We should highlight findings of fungi preferring Mediterranean areas or at least thermophilous forests, such as *Boletus impolitus*, *B. queletii*, *Clathrus ruber*, *Collybia erythropus* and *Hygrophorus russula* (Antonin, Noordeloos 1997; Candusso 1997; Galli 1998) in the montane habitats of the "Alpe della Luna" Nature Reserve.

The presence of two rare *Boletaceae* first observed on the island of Sardinia and newly found in the Nature Reserve of "Valle dell'Inferno e Bandella" is important: *Xerocomus roseoalbidus* Alessio and Littini and *Xerocomus ichnusanus* Alessio, R.Galli and Littini (Galli 1998). *X. roseoalbidus*, found in 1986 and described as a new taxa the following year, is uncommon and grows on the edge of deciduous woods and in more open areas, in extremely arid climatic conditions. The latter was also first observed in Sardinia, then in various locations in the northern Apennines, from Piedmont to Emilia Romagna. This thermoxerophilous mushroom becomes more frequent and abundant in hot and dry years (Galli 1998).

Ramariopsis pulchella (Boud.) Corner, a small coralloid terricolous saprotroph that is reported in various central-northern European studies as being badly threatened because of its great rarity at an international level (Arnolds et al. 1995), has also been sighted in the "Valle dell'Inferno e Bandella" Reserve. Only a few recordings have been cited for Tuscany and the most significant of these were in two other protected areas, the Forests of Berignone-Tatti near Volterra (Province of Pisa) and Cipresseta di S. Agnese, not far from Castellina in Chianti (Province of Siena) (Ricci, Perini 2001).

Mycena diosma was observed in four out of the seven Reserves studied (Alpe della Luna, Montalto, Alta Valle del Tevere, Monti Rognosi,): this species, characteristic of beech forests (Maas Geesteranus 1992) has never been cited for Region of Tuscany and is considered rare or very rare by some authors (Courtecuisse, Duhem 1994; Breitenbach, Kränzlin 1981–2000). It could be confused by a quick look with the common *M. pelianthina*, but once collected the characteristic sweetish/tabac smell and withish edge of the lamelle are conclusive evidence that it is *M. diosma*.

Clitocybe costata, Cortinarius anserinus, *C. bulliardii* are characteristic species on calcareous substrates according to various authors (Boudier 1901; Carbiener et al. 1972-73-74; Høiland 1980; Malençon, Llimona, 1980; Breitenbach, Kränzlin 1981–2000; Brandrud et al. 1990–1998; Gyosheva, Vassilev 1994; Laganà et al. 1999; Salerni et al. 2000b). Their growth in acidophilous *Quercus cerris* woods of the "Alta Valle del Tevere" and not at all on the preferential substrate described can only be explained by the vicinity of the calcareous complex of Monte Castelsavino.

Lactarius deliciosus and *Suillus granulatus*, exclusively linked to conifers (Basso 1999; Galli 1998), have been observed as alien species in the "Valle dell'Inferno

e Bandella" Nature Reserve, where *Quercus cerris* woods constitute the dominant vegetation. It is well known that conifers, even if they are only sporadic trees, influence the characteristics of the fungal community. The same situation can be reported for "Alta Valle del Tevere", where planted conifers allow *Cortinarius allutus* to grow (Consiglio et al. 2004). This is also true for the "Monte Rognosi" Reserve, where important phytogeographic aspects of characteristic garigue and steppe grassland are still present on ultramafic substrates although 50% of the area has been planted with pinus. Although the vegetation found is peculiar to serpentine, this is not reflected by the fungal community. In the small open areas where characteristic plants can be found flowering, species linked to conifers such as *Chroogomphus fulmineus*, *Lactarius deliciosus*, *Russula sanguinea, Suillus granulatus* have been collected (Basso 1999; Courtecuisse, Duhem 1994; Galli 1998; Sarnari 1998).

The situation in the "Alpe della Luna" Reserve is different: in this area a conspicuous population of *Taxus baccata* is of importance. This plant is considered a valuable floristic species and has a fragmentary distribution area. Very few mycological studies refer to this kind of vegetation (De Vries, Kuyper 1990). The data found in the area we studied include species linked to the surrounding deciduous woods but none of the mushrooms characteristic of this important tree. On the other hand, abundant open areas and wide grasslands have permitted the identification of fungal species (*Agaricus arvensis, A. campester, Entoloma ameides, Hygrocybe pratensis, H. psittacina, H. russocoriacea*) that are characteristic of this habitat and considered as a priority vegetation for conservation aspects at a European level (Arnolds 2001). Also the woods of "Sasso di Simone" are frequently interspersed with wide open areas, to be maintained, where the fungi *Agaricus campester* and *Vascellum pratense*, characteristic of montane grasslands, grow.

CONLUSIONS

From this short overview of the research carried out in the 7 Nature Reserves of the Province of Arezzo, it has emerged how important mycological observations can be for the sustainable management of natural resources: the presence or absence of some fungi could be a good bioindicator of the conservation status of the natural environment (Arnolds 1981). A first attempt has been made in order to provide guidelines for appropriate sylvicultural manipulations to safeguard the diversity of larger fungi and to increase the presence of characteristic species. It has been suggested, for example, that reforestation with pines should not take place in areas characterised by serpentine rocks, while more cutting/deforestation should be done in certain zones to increase the steppe garigues. It has also been suggested that some former activities should be reintroduced to encourage the maintenance or expansion of grasslands. The idea of protecting threatened and rare species and the local richness of fungal biota could become a reality in the near future, possibly through the establishment of Important Plant Areas for Fungi, as proposed by the European Plant Conservation Strategy (Anderson 2002; Palmer, Smart 2001).

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