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# Macrofungi as long-term indicators of forest health and management in central Italy

*A. LAGANÀ*, E. SALERNI, C. BARLUZZI, C. PERINI & V. DE DOMINICIS*

*Dip. Scienze Ambientali, Univ. degli Studi di Siena*
*Via P.A. Mattioli, 4 – I 53100 Siena (Italy),*
*Phone: +39 0577 232871 – Fax: +39 0577 232860, e-mail: lagana@unisi.it*

**Abstract** — Here we report the results of a survey of three chestnut coppices in central-southern Tuscany (Italy). The aim of the study was to identify changes in macrofungal flora occurring over the years and to determine their possible causes. Coppices with different ages were chosen in order to obtain information on the effects of different types of management on the macrofungal communities. Changes were found over a period of about 20 years. The forests, however, are in good health according to the criteria proposed by Fellner (1985, 1987) and Schlechte (1987, 1991). The age and type of forest management seem to have a considerable role on the changes observed in the studied macrofungal communities.

**Résumé** — Cet article rapporte les résultats du suivi, sur plusieurs années, de trois bois de chataigners dans le sud-est de la Toscane (Italie) ; ayant pour but d'identifier les modifications de la macroflore fongique et leurs causes possibles. Ces bois furent choisis d'âges différents afin d'étudier l'impact des divers modes de gestion forestière. Des changements ont été observés sur des périodes de l'ordre de 20 ans. Selon les critères proposés par Fellner (1985, 1987) et Schlechte (1987, 1991), ces forêts sont en bonne santé. L'âge et la gestion forestière semblent être des facteurs importants dans les changements observés au niveau des communautés fongiques.

## INTRODUCTION

Public interest in problems associated with environmental pollution has increased in response to recent alarming results of studies on forest decline in central and northern Europe. Forest decline not only involves trees but also shrubs, herbaceous plants, and the microbiological component and physicochemical properties of soil; biodiversity is significantly reduced at all levels (Bottacci *et al.*, 1988; Schütt, 1991). Fungi can be regarded as important bioindicators of perturbations to the ecotrophic stability of forests. In fact, Arnolds (1987), Fellner (1993) and Schlechte (1987) have demonstrated that the mycoflora, especially symbionts, decrease significantly in declining forests. According to Arnolds (1991) and Jakucs (1988), damage to the fungal component precedes decline of the respective forest community by 5-10 years. This suggests that mycological studies can help predict the fate of forests subject to different types of stresses.

* Corresponding author.

Lizon (1993) writes that "evaluation of changes in mycoflora is based on comparison of past and current records...", but that there is still little data on macrofungi collected by long-term monitoring of permanent observation plots. Although field observation is a basic method in biology, few mycologists use such long and time-consuming methods.

Here we report the first results of a study on three chestnut coppices in central-southern Tuscany (Italy). Mycocoenological research was carried out in permanent stations with chestnut trees by Barluzzi *et al.* (1987, 1992) from 1979 to 1982. In 1998 the study was repeated.

The aim of the present study was to detect any changes in the fungal component in these stations and to determine, as far as possible, their causes. The results are also a contribution to what little data exists on the ecology and distribution of certain fungal species in the Mediterranean area. Coppices of different ages are compared to obtain data about the relative influence of forest management on communities of macrofungi.

## MATERIALS AND METHODS

The research was conducted in three permanent stations, each having an area of 2,000 $m^2$, in chestnut coppices in central-southern Tuscany (Italy). The main data of the stations are shown in Tab. 1. Surveys were conducted monthly. During each excursion, all macrofungal species were recorded and counted. By macrofungi we mean fungi that produce fruit bodies visible to the naked eye and larger than 1 mm in size (Arnolds, 1981). Exsiccata were deposited in the Herbarium Universitatis Senensis (SIENA). In this study we did not consider hypogean basidiomycetes or, for comparison reasons with the earlier studies, corticioids and poroids species with resupinate and pileate fruiting bodies. For further details on the methods of this type of research, see Arnolds (1981), Jansen (1981) and Perini & Barluzzi (1987).

The results are shown in Tab. 2. In the first column the trophic group, which was deduced for most taxa from Arnolds *et al.* (1995), is indicated. Species names appear in the second column. Abbreviations of authors names are according to Brummitt & Powell (1992); nomenclature is according to Arnolds *et al.* (1995) and for species not appearing in that work (indicated with an asterisk), according to various texts and monographs (Kühner & Romagnesi, 1953; Romagnesi, 1967; Moser, 1983; Riva, 1988; Jülich, 1989; Brandrud *et al.*, 1989-98; Courtecuisse & Duhem, 1994; Candusso, 1997; etc.). In the other columns, the abundance with which the species was found in the stations is given as mDCv (maximum Density of Carpophores per visit – Arnolds, 1981).

Soil pH was measured by the method reported in Arnolds (1981).

Dissimilarity between stations in the two study periods was expressed as

$$d = 1 - s$$

where s = Jaccard (1901) index. Statistical analysis of data, involving Pearson's $\chi^2$, was performed too.

Tab. 1. Main data of the studied stations (sc = polychromes sericitic scists; s = sandstone; v = verrucano: metasandstones, phyllites and metaconglomerates).

| | *St.1* | *St.2* | *St.3* |
|---|---|---|---|
| Plot surface (sqm) | 2,000 | 2,000 | 2,000 |
| Altitude (m) | 525 | 550 | 870 |
| Slope (°) | 5 | 15 | 5 |
| Exposure | NNE | NE | W |
| Geological substratum | sc | s | v |
| Average pH | 5.17 | 5.13 | 5.67 |
| Tree cover (%) in the period 1979-82 | 90 | 85 | 95 |
| Tree cover (%) in 1998 | 95 | 75 | 100 |
| Shrub cover (%) in the period 1979-82 | 30 | 15 | 50 |
| Shrub cover (%) in 1998 | 40 | 40 | 40 |
| Herb cover (%) in the period 1979-82 | 40 | 30 | 50 |
| Herb cover (%) in 1998 | 45 | 45 | 30 |

## RESULTS AND DISCUSSION

A total of 153 fungal species was found (Tab. 2). In the same stations, Barluzzi *et al.* (1992) reported 152 species of macrofungi. Fig. 1 shows the number of species recorded in the three stations in the two study periods. Apart from small variations in st. 1 and 3, the situation is substantially unchanged.

Comparison of the present results with those of Barluzzi *et al.* (1992) shows that species composition of the fungal community has changed quite considerably. The dissimilarity index, d (described in the previous pages of this work), is useful in this regard. If we consider the number of common and exclusive species in each station in the two periods, we obtain d = 0.45, 0.60 and 0.57 for st. 1, 2 and 3 respectively; so, the dissimilarity between the two studied periods results quite considerable in st. 2 and st. 3 (d > 50%).

In general, only 77 species were common to the two study periods (considering all stations together). Most of the 76 species (45 of which were mycorrhizal) found for the first time in 1998 have a broad ecological range, or are at least common in broadleaf forests; for example *Amanita phalloides, Collybia butyracea, Cortinarius anomalus, C. hinnuleus, C. paleaceus, Inocybe asterospora, I. rimosa, Lepista nuda, Macrolepiota procera* and *Mycena pelianthina*.

An interesting finding in st. 3 was *Boletus rhodoxanthus*, which Carbiener *et al.* (1972-73-74) and Alessio (1985) report as a preferential calcicolous species. Barluzzi *et al.* (1992) reports that the lithological substrate in all stations is silicious. Analysis of pH in summer 1999 showed a limited area with neutral-basic pH (6.5) in st. 3, in the very place where this species was found in autumn. The same considerations apply to *Cortinarius olivaceofuscus*, which Marchand (1971-86), Brandrud *et al.* (1989-98) and Courtecuisse & Duhem (1994) report as typically calcicolous.

Tab. 2. Synthesis of mycocoenological surveys carried out in 1998 (M = mycorrhizal; Sh = sapr. on humus; Sl = sapr. on litter; Sw = lignicolous; P = parasities). N. ers in 3th, 4th and 5th columns indicate species aboundance expressed as Arnolds' (1981) mDCv.

| *TG* | *SPECIES* | *St. 1* | *St. 2* | *St. 3* |
|---|---|---|---|---|
| Sw | Mycena inclinata (Fr.) Quél. | 5 | 5 | 5 |
| M | Hebeloma sinapizans (Fr.) Gillet | 2 | 1 | 5 |
| M | Laccaria laccata s. 1. | 1 | 5 | 2 |
| M | Cortinarius duracinus Fr. | 3 | 3 | 1 |
| M | Tricholoma ustaloides Romagn. | 3 | 2 | 1 |
| M | Cortinarius trivialis J. E. Lange | 1 | 2 | 3 |
| Sh(M?) | Entoloma rhodopolium (Fr.: Fr.) P. Kumm. f. nidorosum (Fr.) Noordel. | 3 | 1 | 1 |
| Sl | Mycena pura (Pers.: Fr.) P. Kumm. | 3 | 1 | 1 |
| M | Hebeloma crustuliniforme (Bull.) Quél. ss. str. | 1 | 1 | 3 |
| M | Cortinarius paleaceus Fr. ss. str. | 1 | 2 | 1 |
| M | Lactarius chrysorrheus Fr. | 1 | 2 | 1 |
| M | Lactarius decipiens Quél. | 1 | 2 | 1 |
| Sw | Mycena vitilis (Fr.) Quél. | 1 | 2 | 1 |
| M | Russula risigallina (Batsch) Sacc. | 1 | 1 | 2 |
| Sl | Collybia buryracca (Bull.: Fr.) P. Kumm. | 1 | 1 | 1 |
| M | Hydnum repandum L.: Fr. | 1 | 1 | 1 |
| M | Russula fragilis (Pers.: Fr.) Fr. ss. str. | 1 | 1 | 1 |
| Sl | Mycena galopus (Pers.: Fr.) P. Kumm. | 4 | 3 | |
| M | Hydnellum concrescens (Pers.) Banker ss. str. | 3 | 4 | |
| SI | Rickenella fibula (Bull.: Fr.) Raithelh. | 3 | 3 | |
| M | Russula cyanozantha Schaeff.: Fr. | 3 | 1 | |
| Sl | Rutstroemia echinophila (Bull.: Fr.) Höhn. | 3 | 1 | |
| M | Tricholoma saponaceum (Fr.: Fr.) P. Kumm. | 1 | 3 | |
| M | Cortinarius lividoochraceus (Berk.) Berk. | 2 | 2 | |
| Sh | Agaricus silvicola (Vittad.) Sacc. ss. str. | 2 | 1 | |
| Sh(M) | Clavulina coralloides (L.: Fr.) J. Schröt. ss. str. | 1 | 2 | |
| Sl | Flammulaster carpophilus (Fr.) Earle | 1 | 2 | |
| M | Hebeloma fastibile (Pers.: Fr.) P. Kumm. | 1 | 2 | |
| M | Inocybe geophylla (Fr.: Fr.) P. Kumm. | 1 | 2 | |
| Sw | Mycena maculata P. Karst. | 1 | 2 | |
| Sl | Mycena sanguinolenta (AIb. & Schwein.: Fr.) P. Kumm. | 1 | 2 | |
| M | Cantharellus tubaeformis Fr.: Fr. | 1 | 1 | |
| Sh(M?) | Clitopilus prunulus (Scop.: Fr.) P. Kumm. | 1 | 1 | |
| M | Cortinarius obtusus (Fr.: Fr.) Fr. ss. str. | 1 | 1 | |
| M | Cortinarius safranopes Rob. Henry | 1 | 1 | |
| M | Hebeloma hiemale Bres. | 1 | 1 | |
| M | Inocybe flocculosa (Berk.) Sacc. * | 1 | 1 | |
| Sh | Lyophyllum deiberatum (Britzelm.) Kreisel | 1 | 1 | |
| M | Russula nigricans (Bull.) Fr. * | 1 | 1 | |
| M | Russula rosea Pers. | 1 | 1 | |
| Sw(P?) | Xeruia pudens (Pers.) Singer | 1 | 1 | |

| *TG* | *SPECIES* | *St. 1* | *St. 2* | *St. 3* |
|---|---|---|---|---|
| Sl | Marasmius quercophilus Pouzar | 4 | | 4 |
| M | Craterellus cornucopioides (L.: Fr.) Pers. | 3 | | 1 |
| M | Amanita pantherina (DC.: Fr.) Krombh. | 1 | | 3 |
| M | Amanita rubescens Pers.: Fr. | 1 | | 3 |
| Sl | Clitocybe gibba (Pers.: Fr.) P. Kumm. | 2 | | 1 |
| M | Hygrophorus discoxanthus (Fr.) Rea | 2 | | 1 |
| Sl | Mycena rosea (Bull.) Gramberg* | 1 | | 2 |
| M | Amanita vaginata (Bull.: Fr.) Lam. ss. str. | 1 | | 1 |
| M | Boletus edulis Bull.: Fr. ss. str. | 1 | | 1 |
| M | Cortinarius anomalus (Fr.: Fr.) Fr. ss. str. | 1 | | 1 |
| M | Cortinarius cfr. obtusus | 1 | | 1 |
| Sw | Mycena polygramma (Bull.: Fr.) Gray | 1 | | 1 |
| M | Russula persicina Krombh. | 1 | | 1 |
| Sl(Sw) | Marasmius epiphyllus (Pers.: Fr.) Fr. | | 3 | 3 |
| Sh(M?) | Entoloma scricatum (Britzelm.) Sace. | | 3 | 2 |
| M | Tricholoma sulphureum (Bull.: Fr.) P. Kumm. | | 1 | 4 |
| Sw | Marasmius rotula (Scop.: Fr.) Fr. | | 1 | 3 |
| Sh | Lycoperdon perlatum Pers.: Pers. | | 2 | 1 |
| M | Russula deica Fr. ss. str. | | 2 | 1 |
| M | Cortinarius alboviolaceus (Pers.: Fr.) Fr. | | 1 | 1 |
| M | Cortinarius calochrous (Pers.: Fr.) Fr. | | 1 | 1 |
| Sh | Entoloma hirtipes (Schumach.: Fr.) M. M. Moscr | | 1 | 1 |
| Sw | Mycena galericulata (Scop.: Fr.) Gray | | 1 | 1 |
| Sl | Marasmius androsaceus (L.: Fr.) Fr. | 4 | | |
| M | Cortinarius cristallinus Fr. ss. str. | 3 | | |
| Sl | Marasmius epiphylloides (Rea) Sacc. & Trott. | 3 | | |
| Sw | Psathyrella piluliformis (Bull.: Fr. ;) P. D. Orton ss. str. | 3 | | |
| Sh(M?) | Entoloma rhodopolium (Fr.: Fr.) P. Kumm. | 2 | | |
| M | Inocybe splendens Heim. var. splendens | 2 | | |
| M | Lactarius vellereus (Fr.: Fr.) Fr. | 2 | | |
| M | Russula decipiens (Singer) Svreek | 2 | | |
| Sh | Clavariadelphus pistillaris (Fr.: Fr.) Donk | 1 | | |
| Sl | Clitocybe odora (Bull.: Fr.) P. Kumm. | 1 | | |
| M | Cortinarius boudieri Rob. Henry* | 1 | | |
| M | Cortinarius coerulescens (Schaeff.) Fr. | 1 | | |
| M | Cortinarius torvus (Bull.: Fr.) Fr. | 1 | | |
| Sw | Galerina cfr. marginata | 1 | | |
| Sh | Galerina laevis (Pers.) Singer | 1 | | |
| Sh | Hygrocybe obrussea (Fr.: Fr.) Wünsche | 1 | | |
| M | Inocybe cincinnata (Fr.: Fr.) Quél. | 1 | | |
| M | Inocybe flavella P. Karst. | 1 | | |
| M | Inocybe glabripes Rick. | 1 | | |
| M | Inocybe leptophylla Atk. | 1 | | |
| M | Inocybe splendens Heim. var. phaeoleuca (Kühner) Kuyper | 1 | | |
| M | Lactarius controversus (Pers.: Fr.) Fr. | 1 | | |

| *TG* | *SPECIES* | *St. 1* | *St. 2* | *St. 3* |
|---|---|---|---|---|
| Sh | Leotia lubrica (Scop.: Fr.) Pers. | 1 | | |
| Sh | Lepiota clypeolaria (Bull.: Fr.) P. Kumm. | 1 | | |
| Sh | Mycena albidolilacea Kühner & Maire | 1 | | |
| M | Phellodon confluens (Pers.) Pouzar | 1 | | |
| Sw | Pluteus semibulbosus (Lasch.: Fr.) Gillet | 1 | | |
| M | Russula aurata (With.) Fr. * | 1 | | |
| M | Russula foetens Pers.: Fr. | 1 | | |
| M | Russula laurocerasi Melzer var. fragrans (Romagn.) Kuyper & Vuure | 1 | | |
| M | Russula minutula Velen. | 1 | | |
| Sw | Xerula melanotricha Dörfelt* | 1 | | |
| Sw(P?) | Xerula radicata (Relhan: Fr.) Dörfelt | 1 | | |
| Sw | Xylaria hypoxylon (L.: Fr.) Grey. | 1 | | |
| Sl(P?) | Collybia amanitae (Batsch) Kreisel | | 3 | |
| Sw | Hymenoscyphus calyculus (Sow.: Fr.) W. Phill. ss. str. | | 3 | |
| Sl | Mycena abramsii (Murrill) Murrill | | 3 | |
| P(Sw?) | Collybia fusipes (Bull.: Fr.) Quél. | | 2 | |
| Sl | Hymenoscyphus fructigenus (Bull.: Fr.) Gray | | 2 | |
| M | Albatrellus cristatus (Schaeff.: Fr.) Kotl. & Pouzar* | | 1 | |
| M | Amanita citrina (Schaeff.: Fr.) Gray* | | 1 | |
| M | Cortinarius cfr. acutus | | 1 | |
| M | Cortinarius diosmus Kühner | | 1 | |
| M | Cortinarius nemorensis (Fr.) J. E. Lange | | 1 | |
| M | Cortinarius purpurascens (Fr.: Fr.) Fr. | | 1 | |
| M | Cortinarius xanthophyllus Cooke* | | 1 | |
| M | Hydnum rufescens Fr.: Fr. | | 1 | |
| M | Inocybe praetervisa Quél. | | 1 | |
| M | Lactarius subumbonatus Lindgr. * | | 1 | |
| Sh | Macrolepiota konradii (P. D. Orton) M. M. Moser | | 1 | |
| Sh | Macrolepiota procera (Scop.: Fr.) Singer | | 1 | |
| Sl | Marasmius bulliardii Quél. | | 1 | |
| Sl | Mycena olivaceomarginata (Massee) Massee | | 1 | |
| Sl/Sw | Mycena pelianthina (Fr.: Fr.) Quél. | | 1 | |
| Sw(P) | Omphalotus olearius (DC.: Fr.) Singer* | | 1 | |
| Sw | Phaeomarasmius erinaceus (Fr.: Fr.) Singer | | 1 | |
| M? | Ramaria flavescens (Schaeff.) Petersen | | 1 | |
| M | Tricholoma acerbum (Bull.: Fr.) Quél. | | 1 | |
| M | Tricholoma album (Schaeff.: Fr.) P. Kumm. | | 1 | |
| M | Tricholoma atrosquamosum (Chev.) Sacc. | | 1 | |
| Sw(Sl) | Tubaria cfr. furfuracea | | 1 | |
| M | Entoloma sinuatum (Bull. cx Pers.: Fr.) P. Kumm. | | | 4 |
| Sw | Psilocybe fascicularis (Huds.: Fr.) Noordel. | | | 3 |
| M | Cortinarius anserinus (Velen.) Rob. Henry | | | 2 |
| M | Cortinarius castaneus (Bull.: Fr.) Fr. | | | 2 |
| M | Cortinarius hinnuleus Fr. ss. str. | | | 2 |
| M | Cortinarius rufoolivaceus (Pers.: Fr.) Fr. * | | | 2 |

| *TG* | *SPECIES* | *St. 1* | *St. 2* | *St. 3* |
|---|---|---|---|---|
| M | Inocybe fuscidula Velen. | | | 2 |
| Sh | Agaricus niveolutescens Huijman | | | 1 |
| M | Amanita phalloides (Fr.: Fr.) Link | | | 1 |
| M | Boletus luridus Schaeff.: Fr. | | | 1 |
| M | Boletus rhodoxanthus (Krombh.) Kallenb. | | | 1 |
| Sl | Clitocybe nebularis (Batsch: Fr.) P. Kumm. | | | 1 |
| M | Cortinarius cfr. balteatus | | | 1 |
| M | Cortinarius evernius (Fr.: Fr.) Fr. | | | 1 |
| M | Cortinarius infractus (Pers.: Fr.) Fr. | | | 1 |
| M | Cortinarius olidus J.E. Lange* | | | 1 |
| M | Cortinarius olivaceofuscus Kühner | | | 1 |
| M | Hygrophorus lindtneri M. M. Moser* | | | 1 |
| M | Inocybe asterospora Quél. | | | 1 |
| M | Inocybe rimosa (Bull.: Fr.) P. Kumm. | | | 1 |
| Sl | Lepista nuda (Fr.: Fr.) Cooke | | | 1 |
| Sl | Mycena pura (Pers.: Fr.) P. Kumm. f. alba (Gillet) Kühner | | | 1 |
| M | Paxillus involutus (Batsch: Fr.) Fr. | | | 1 |
| Sh | Psathyrella cfr. dicrani | | | 1 |
| M | Scleroderma cfr. citrinum | | | 1 |
| M | Tricholoma argyraceum (Bull.: Fr.) Sacc. * | | | 1 |
| M | Tricholoma scalpturarum (Fr.) Quél. * | | | 1 |

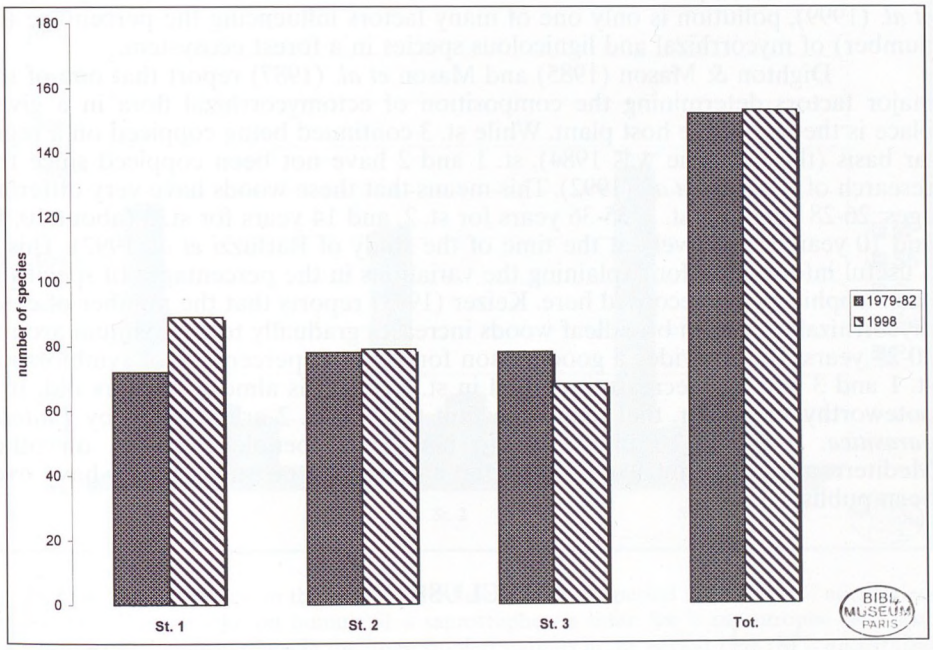


Fig. 1. Species richness of fungi in the three studied stations. Comparison between the two research periods (1979-82 and 1998).

Of the species found in 1979-82, 75 seem to have disappeared from the mycoflora of these chestnut coppices. The fact that as many as 38 of these are saprotrophic suggests that weather may be a causal factor. Summer 1998 was particularly hot and dry, penalizing all species that fruit after the first rains, such as many saprotrophs. Moreover, the lack of fruitbodies of fungi doesn't mean that species are not present at the study site; some species, infact, do not produce the fruitbodies every year (Arnolds, 1995).

Among the species found for the first time in st. 1 and 2, there were many Russulas, which Hintikka (1988) mentions as abundant in old forests. In st. 2, *Tricholoma saponaceum*, which Keizer (1993) cites as a late-stage species, fruited abundantly in 1998. However, most research into successions and hence early- and late-stage species has been in coniferous woods (Dighton *et al.*, 1986; Hintikka, 1988; Termorshuizen, 1990; Jansen, 1991) and only infrequently in broadleaf woods (Last *et al.*, 1984; 1987).

Figs. 2a and 2b show percentages of species in the various trophic groups, station by station, in the two study periods. A higher percentage of mycorrhizal taxa were found in 1998 than in 1979-82 in st. 1 and 3, at the expense of saprotrophs. In st. 2, there were lower percentages of mycorrhizal species and lignicolous saprotrophs in 1998 than in the earlier period, whereas saprotrophs of humus and litter increased. Statistical analysis (Pearson's $c^2$) showed that the changes in the number of mycorrhizal species in each station were statistically significant ($\chi^2 = 7.17$; $p < 0.05$). In an attempt to find a direct relation between fungal species and health status of forest ecosystems, Fellner (1985, 1987) and Schlechte (1987, 1991) found that in polluted areas, the percentage of mycorrhizal species was below 40%, and in the worst cases, below 20%. The condition of the chestnut coppices therefore seems to be good, despite the reduction of symbionts recorded in st. 2, for which this parameter was 53.16% in 1998. However, as stated by Laganà *et al.* (1999), pollution is only one of many factors influencing the percentage (or number) of mycorrhizal and lignicolous species in a forest ecosystem.

Dighton & Mason (1985) and Mason *et al.* (1987) report that one of the major factors determining the composition of ectomycorrhizal flora in a given place is the age of the host plant. While st. 3 continued being coppiced on a regular basis (the last time was 1984), st. 1 and 2 have not been coppiced since the research of Barluzzi *et al.* (1992). This means that these woods have very different ages: 26-28 years for st. 1, 35-36 years for st. 2, and 14 years for st. 3 (about 10, 18 and 10 years respectively at the time of the study of Barluzzi *et al.* 1992). This is a useful information for explaining the variations in the percentages of species in each trophic group, recorded here. Keizer (1993) reports that the number of ectomycorrhizal species in broadleaf woods increases gradually to a maximum around 20-25 years. This provides a good reason for the high percentage of symbionts in st. 1 and 3 and the decrease recorded in st. 2, which is almost 40 years old. It is noteworthy, moreover, that many chestnut trees in st. 2 are affected by *Endotia parasitica*. It would be interesting to have mycocoenological data on other Mediterranean chestnut woods of different ages, but no such studies have ever been published.

## CONCLUSIONS

The percentage of mycorrhizal species has shown variations in the last 10 years, increasing in st. 1 and 3 and decreasing considerably in st. 2. The changes

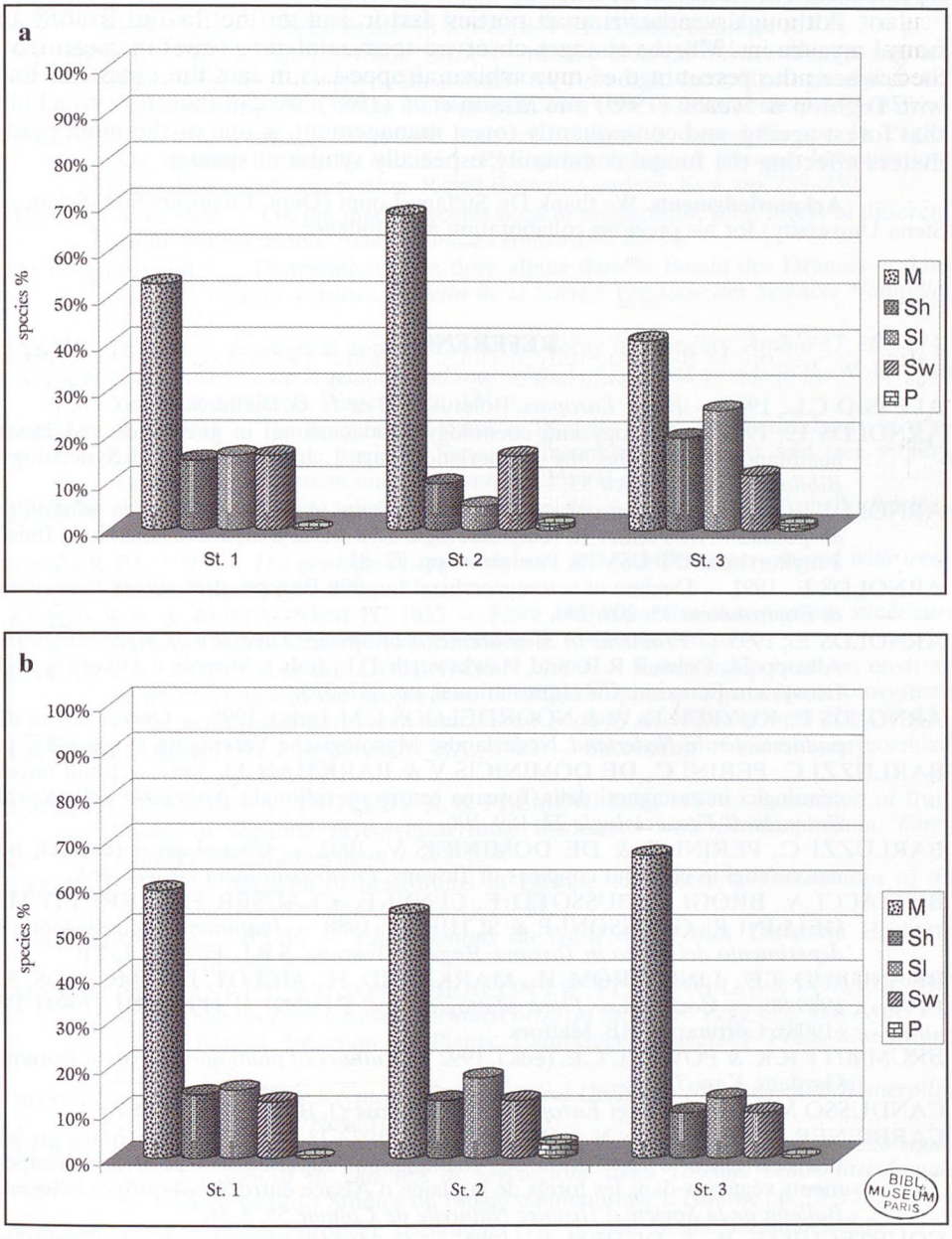


Fig. 2a, b. **a:** Trophic groups in the three studied stations in the period 1979-82 (M = micorrhizal species; Sh = saprotrophe on humus; Sl = saprotrophe on litter; Sw = saprotrophe on wood; P = parasite). **b:** Trophic groups in the three studied stations in the period 1998 (M = micorrhizal species; Sh = saprotrophe on humus; Sl = saprotrophe on litter; Sw = saprotrophe on wood; P = parasite).

were found to be statistically significant. The mycorrhizal ratio, considered by various authors to be an index of forest health, indicates that the coppices of the three stations are in good health.

Although weather is an important factor, and did not favour fruiting of fungal mycelia in 1998, the changes observed seem related to forest management. St. 2, where the percentage of mycorrhizae dropped, is in fact the oldest. In line with Dighton & Mason (1985) and Mason *et al.* (1987), we can therefore conclude that forest ageing, and consequently forest management, is one of the main parameters affecting the fungal community, especially symbiont species.

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