Ecological features of macromycetes in *Eucalyptus* reforestations in Sicily (southern Italy)

G. Venturella & M. L. Gargano

Dipartimento di Scienze Botaniche, Università di Palermo, Via Archirafi 38, I-90123 Palermo, Italy

Venturella G. & Gargano M. L. (2008) Ecological features of macromycetes in *Eucalyptus* reforestation in Sicily (southern Italy). – Sydowia 61 (1): 117–133.

The objective of this work was to compare and estimate the ecological features of 192 macromycetes, including nine hypogeous and three semi-hypogeous fungi, collected in Sicilian areas reforested with *Eucalyptus*. The number of mycorrhizal fungi turned out to be only 22 % of the taxa recorded so far from other areas, and this underlines the difficulties of eucalyptus trees in adapting to the pedological and climatic conditions of Sicily.

Keywords: fungal diversity, mycorrhizae, reforested areas, Mediterranean area.

During the ‘60s, an intensive work of reforestation with exotic tree species was carried out in Sicily by the Forestry Administration. A huge number of pines, cypresses, cedars and eucalyptus trees were planted and certain areas were seeded with oaks and ash trees with two aims: to guarantee an adequate plant coverage in areas exposed to soil erosion, and to obtain wood.

The survey carried out by Moggi in 1956 underlined the presence of 15 taxa of *Eucalyptus*, but the most representative species in the region were *Eucalyptus camaldulensis* Dehnh., *E. gomphocephala* DC., *E. occidentalis* Endl., and *E. globulus* Labill.

Nowadays *Eucalyptus* reforestation is mainly concentrated in the central and central-western sector of Sicily covering about 33 489 ha, i.e. 25.5 % of the broad-leaved woods (AA.VV. 1992).

Owing to the geo-climatic and ecological features of Sicily, reforestation with *Eucalyptus* gave poor economic results as to wood production and rational exploitation of timber also because of the lack of synergy with the wood processing industry and provoked little scientific interest by botanists, silviculturers, and environmentalists.

Although a wide range of fungi grow in *Eucalyptus* woods their ecology and distribution still have not been widely investigated in Italy while lists of the mycobiota of eucalyptus woods from other

countries are available on the web (Sankaran *et al.* 1995). (www.cybertruffle.org.uk/eucafung/eng/index.htm)

The fungal communities on bark, in sapwood and heartwood of *Eucalyptus* were investigated by Simeto *et al.* (1995).

The main objective of this work was to survey the ecology of the mycobiota in reforestations with *Eucalyptus*; the studies were carried out in the framework of a wide project of census of macromycetes in Sicily.

Materials and Method

The survey was carried out according to the standard methods tested by the Laboratory of Mycology of the Department of Botany (University of Palermo) for the census of macromycetes in Sicily, following the guidelines developed by the Working Group for Mycology of the Italian Botanical Society.

The first step was the selection of different types of vegetation and soils on maps (scale 1:50 000 and 1:250 000) published by the Italian Geographic Military Institute (I.G.M.I.) and by Fierotti (1988).

Afterwards vegetation and soils were studied in the field: fruiting bodies were collected twice a week in the selected areas.

Types of vegetation

A number of eucalyptus woods, located at different altitudes in the Sicilian territory were investigated from January 2004 until December 2005; they correspond to the following five types of vegetation, codified with Roman numbers (Table 1).

I Reforestation with *E. camaldulensis*;

II Mixed reforestation with *E. camaldulensis*, *E. gomphocephala,* and *E. occidentalis*;

III Mixed reforestation with eucalyptus and *Acacia saligna* (Labill.) H. L. Wendl. and *Pinus pinea* L.;

IV Mixed reforestation with eucalyptus and *Fraxinus ornus* L., *Quercus ilex* L., *Q. leptobalanos* Guss., *Q. pubescens* Willd., *Q. suber* L.;

V Mixed reforestation with eucalyptus and *Cupressus sempervirens* L., *Pinus halepensis* Miller and *P. pinea* L.

Types of soil

The selected eucalyptus woods stand on different substrata and soils belonging to 15 associations, codified in lower cases (Table 1) and described by the Soil Survey Staff (1975) as follows:

a Rock outcrop; Lithic Xerorthents;
b Typic Xerorthents; Lithic Xerorthents; Typic and/or Vertic Xerochrepts;
c Typic Xerorthents; Typic and/or Vertic Xerochrepts; Typic and/or Vertic xerofluvents and/or Typic chromoxererts and/or Typic pelloxererts;
d Typic Xerorthents; Typic and/or Vertic Xerochrepts;
e Typic Xerorthents; Typic and/or Vertic xerofluvents and/or Typic chromoxererts e/o pelloxererts;
f Typic Xerorthents; Typic Xerochrepts; Typic haploxeralfs;
g Typic and/or Vertic xerofluvents; Typic and/or Vertic Xerochrepts;
h Typic chromoxererts and/or Typic pelloxererts;
i Typic Xerochrepts; Calcixerollic Xerochrepts; Lithic Xerorthents;
j Calcixerollic Xerochrepts; Lithic Xerorthents; Typic Xerorthents;
k Typic Xerochrepts; Vertic Xerochrepts; Typic chromoxererts and/or Typic pelloxererts;
l Typic Xerochrepts; Typic haploxeralfs; Typic and/or Lithic Xerorthents;
m Typic and/or Lithic Rhodoxeralfs; Lithic Xerorthents;
n Typic and/or Lithic Rhodoxeralfs; Calcixerollic Xerochrepts; Lithic Xerorthents;
o Dunelands -Typic Xeropsamments.

Identification of fungi

Identification was carried out using fresh ascomata and basidiomata.

Macromorphological characters of specimens were evaluated with a Leica MS5 binocular microscope as follows:

Pileus (size, shape, color, surface, shape and surface of margin, flesh, presence or absence of latex), characters of lamellae, stipe (size, attachment, shape, surface, color and color changes, consistency, flesh, presence or absence of veils), growth habit, type of ascomata, basidiomatal attachment to substrate, pore color.

Microscopic features (spores, cystidia, basidia, basidioles, hyphal systems, hyphal walls, septations, hyphal branching, hyphal inflations, specialized hypha) were evaluated with a Leica DLMB microscope using tap water and chemical reagents such as 95% ethanol, 3% potassium hydoxyde (KOH) or 5–10% ammonium hydroxyde (NH_4OH), Teepol, acetocarmine, chloral hydrate, Congo red, cotton blue, cresyl blue, fuchsin, guaiac, hydrochloric acid, Melzer's reagent, methylene blue, sodium hydroxyde (NaOH), sulphobenzaldehyde and sulphuric acid.

The following keys were used for identification: Basso (1999), Bernicchia (2005), Breitenbach & Kränzlin (1984, 1986, 1991, 1995, 2000), Candusso & Lanzoni (1990), Cortecuisse & Duhem (1994), Dennis (1981), Eriksson & Ryvarden (1973, 1975, 1976), Eriksson *et al*. (1978, 1981, 1984), Hjortstam *et al*. (1987, 1988), Jülich (1989), Moser (1980), and Ryvarden & Gilbertson (1993–1994).

Nomenclature

The scientific binomials and trinomials of recorded taxa are according to www.indexfungorum.org/ Names/Names.asp with the exception of *Setchelliogaster*, because field experiences (Venturella *et al*. 2004) underlined that the taxonomic distinction between *S. tenuipes* var. *tenuipes* and *S. tenuipes* var. *reophyllus* by Martin & Moreno (2001) was more suitable than the interpretation of Lago *et al*. (2001) who considered them as synonyms.

The nomenclature of vascular plants was reported according to Pignatti (1982).

Ecological categories

The ecological categories of fungi were referred to Arnolds *et al*. (1999) and codified as follows:

S = saprobe
Sh = saprobe on humus
Sl = saprobe on woods
St = terricolous saprobe
M = mycorrhizal
Np = necrotroph parasite

Herbarium samples

The herbarium specimens were prepared in a hamper ventilator and kept in the *Herbarium Mediterraneum* (PAL).

Results

The survey carried out in eucalyptus woods of Sicily pointed out a number of macromycetes corresponding to 192 taxa (18 ascomycetes and 174 basidiomycetes, including nine hypogeous and three semi-hypogeous fungi), i.e. 185 species, six varieties and one form included in 100 genera belonging to 48 families.

Each recorded taxon is reported in Table 1 together with data on ecological categories, period of fructification, type of vegetation, type of soil and altitude.

The period of fructification of basidiomata and ascomata is mostly concentrated in autumn, 117 taxa (60.9%) were collected only once during the two-year period of observation.

The basidiomycetes *Agrocybe praecox*, *Inocybe roseipes,* and *Scleroderma verrucosum* grew exclusively in spring. Many other fungi were characterized by a double period of fructification (autumn and spring) while no basidiomata and ascomata were observed from July to August. A high percentage of taxa (44%) were collected in reafforestation with *E. camaldulensis*, 48 taxa were related to mixed reafforestation with eucalyptus, conifers and other broad-leaved plants; only 12 taxa were collected at the sea level on sandy soils in mixed reafforestation with *E. camaldulensis* and *Acacia saligna*. A restricted number of taxa (5.7%) were collected at altitudes higher than 1000 m.

As reported in Table 1, the saprobes are the most representative ecological category (137 taxa) followed by mycorrhizal species (46 taxa, one uncertain) and necrotroph parasites (nine taxa). A huge number of saprobes *sensu stricto* (68 taxa, one uncertain) are listed in Table 1 followed by saprobes on ground (19 taxa), saprobes on litter (39 taxa) and saprobes on humus (10 taxa).

The fungi growing in eucalyptus woods are predominantly indifferent to the type of soil and to its related substrata. A possible relationship with soil type and reaction was found in the case of twenty-four taxa exclusively collected on Typic Xerochrepts; Calcixerollic Xerochrepts and Lithic Xerorthents (Table 1) evolved on limestones and dolomitic limestones with neutral or subalkaline reaction. Other twenty-one taxa were related to the association Typic Xerorthents; Typic and/or Vertic Xerochrepts characterized by subalkaline reaction. Another ecological link with the pedological substrata could be pointed out in the case of taxa growing on sandy soils belonging to the association Dunelands-Typic Xeropsamments. Besides *Agrocybe praecox*, *Lyophyllum decastes*, *Macrolepiota fuligineosquarrosa* and *M. konradii* were exclusively collected in eucalyptus woods planted on Typic Xerochrepts; Typic Haploxeralfs; Typic and/or Lithic Xerorthents evolved on limestones and flyshoid sequences in a range of pH from subacid to alkaline.

The basidiomycetes *Amanita echinocephala*, *A. pantherina*, *Gymnopilus sapineus*, *Lepiota forquignonii*, *Scleroderma bovista* and *Tubaria hiemalis* seemed to be related to the pedological association Typic Xerorthents; Typic Xerochrepts; Typic Haploxeralfs evolved on subacid or subalkaline calcarenites.

The necrotroph parasite *Bjerkandera adusta* was collected in the town of Palermo on timber of eucalyptus inside the Botanical Garden and the Favorita Park, two sites characterized by soil belonging

to the association Typic and/or Lithic Rhodoxeralfs; Lithic Xerorthents evolved on calcarenites.

Steccherinum fimbriatum is the only species collected in reafforestation with eucalyptus planted on soil belonging to the association Typic Xerorthents; Lithic Xerorthents; Typic and/or Vertic Xerochrepts, evolved on gypsum and sulphur rocks.

The selvicoltural practice in eucalyptus woods of Sicily is occasional and a considerable amount of wood residues can be found in the ground cover. The stumps and the trunks are colonized by *Auricularia mesenterica*, *Crepidotus calolepis*, *Mycena galericulata*, *M. inclinata*, *Pluteus cervinus* var. *cervinus*, *P. romellii*, *P. thomsonii* and *Trametes versicolor.* During the whole year, the stumps and the branches of eucalyptus are colonized by basidiomata of *Stereum hirsutum* and by three necrotroph parasites: *Laetiporus sulphureus*, *Omphalotus olearius,* and *Phellinus torulosus*.

Other species such as *Auricularia auricula-judae*, *Bisporella citrina*, *Gloeophyllum sepiarium*, *Gymnopilus junonius*, *G. sapineus*, *Meruliopsis corium*, *M. tremellosus*, *Schizophyllum commune*, *Schizopora paradoxa*, *Trichaptum fuscoviolaceum,* and *Tyromyces subcaesius* seem to prefer trunks fallen on the ground.

A considerable number of saprobes were observed on branches of *E. camaldulensis* and *E. occidentalis*: *Calocera cornea*, *Coriolopsis gallica*, *Crepidotus cesatii* var. *cesatii*, C. *variabilis* var. *variabilis*, *Exidia thuretiana*, *Funalia trogii*, *Phlebiopsis ravenelii*, *Pluteus nanus*, *Polyporus arcularius*, *Radulomyces confluens*, *Skeletocutis nivea*, *Steccherinum fimbriatum*, *S. ochraceum*, *Tapinella panuoides* and *Tremella mesenterica*.

Calocera cornea also grows on timber of *E. camaldulensis* while the smallest wood residues (twigs, logs, root residues, etc.) are predominantly colonized by *Crinipellis scabella*.

Fire events in eucalyptus woods in Sicily are mainly due to the negligence of forest workers or to lack of attention of people making bonfires during festivities and/or weekends. The burnt areas are colonized by specialized fungi such as *Anthracobia melaloma* and *Pholiota highlandensis*.

In the investigated areas, grazing is responsible for the presence of cow dung. On such type of substratum, ascomata or basidiomata of *Ascobulus stercorarius*, *Cheilymenia granulata*, *Panaeolus campanulatus,* and *Stropharia coronilla* are frequent.

Discussion

The eucalyptus reforestation in Sicily is considered as unproductive by foresters and ecologically negligible by biologists and botanists. The wood biomass is inadequate to any type of use and a

Tab. 1. – Ecological features of recorded taxa.

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Agaricus arvensis Schaeff.	St	Jan, Apr, Nov	I	c-l-o	300–600
Agaricus bitorquis (Quél.) Sacc.	St	Jan	I	i	550
Agaricus campestris L. var. *campestris*	St	Jan, Oct-Nov	I	a-c-d-l-o	550–1080
Agaricus chionodermus Pilát	S	Jan-Feb, Nov, Dec	III	o	5
Agaricus fissuratus (F.H. Møller) F.H. Møller	St	Jan	I-II-IV-V	e-h-i-j	600
Agaricus iodosmus Heinem.	St	Oct	I	i	610
Agaricus langei (F.H. Møller & Jul. Schäff.) Maire	St	Nov	I	i	550
Agaricus lanipes (F.H. Møller & Jul. Schäff.) Singer	S	Jan-Feb, Nov, Dec	III	o	5
Agaricus lutosus (F.H. Møller) F.H. Møller	Sh	Oct	I	c-l-o	630
Agaricus moelleri Wasser	St	Oct	I	c-l-o	630
Agaricus pilatianus (Bohus) Bohus	St	Nov	I	c-l-o	350–550
Agaricus porphyrizon P.D. Orton	Sh	Nov-Dec	I-II-IV-V	e-h-i-j	570
Agaricus pseudopratensis (Bohus) Bohus var. *pseudopratensis*	St	Nov	I	c-l-o	350–500
Agaricus pseudopratensis var. *niveus* Bohus	St	Nov	I	c-l-o	550–595
Agaricus silvicola (Vihad.) Peck	Sh	Oct, Dec	I-II-IV-V	e-h-i-j	200–550
Agaricus urinascens (Jul. Schäff. & F.H. Møller) Singer var. *urinascens*	St	Jan	I	i	550
Agaricus xanthodermus Genev.	St	Jan	I	i	550–595
Agrocybe praecox (Pers.) Fayod	St	Apr	II	l	350–450
Amanita echinocephala (Vittad.) Quél.	M	Nov	IV-V	f	300–620
Amanita pantherina (DC.) Krombh. var. *pantherina*	M	Nov	IV-V	f	400–620
Amanita vaginata (Bull.) Lam. var. *vaginata*	M	Oct	I	i-k	610
Amanita vaginata (Bull.) Lam. f. *vaginata*	M	Oct	I	i-k	550
Anthracobia melaloma (Alb. & Schwein.) Arnould	S	Oct	I	i-k	610
Arrhenia rickenii (Hora) Watling	S	Oct	I	i-k	630
Ascobulus stercorarius (Bull.) J. Schröt.	S	Oct	I	i-k	550

Tab. 1. – continued

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Astraeus hygrometricus (Pers.) Morgan	M	Nov	I	i-k	550
Auricularia auricula-judae (Bull.) Quél.	Np	Oct	I	d-e-h-i-k	200–560
Auricularia mesenterica (Dicks.) Pers.	Sl	Oct	I	i-k	610
Bisporella citrina (Batsch) Korf & S.E. Carp.	Sl	Oct, Dec	I	d-e-h	200–560
Bjerkandera adusta (Willd.) P. Karst.	Np	Dec-Jan	I	m	0–60
Bovista plumbea Pers.	S	Jan, Nov	I	d-f-i-k-l	550–620
Calocera cornea (Batsch) Fr.	Sl	Nov-Dec	I	d-i-k	200–570
Cheilymenia granulata (Bull.) J. Moravec	S	Jan, Oct	I-IV	d-i-k-l	550–600
Chlorophyllum rhacodes (Vittad.) Vellinga	S	Oct-Nov	I	e-h-i	560
Clathrus ruber P. Micheli ex Pers.	S	Jan, Oct	I-II	e-h-i-k	560
Clavulina cinerea (Bull.) J. Schröt.	S	Dec	I	e-h	560
Clitocybe alexandri (Gillet) Konrad	S	Nov	IV	i	570
Clitocybe amarescens Harmaja	S	Nov	III	o	5
Clitocybe candicans (Pers.) P. Kumm.	S	Nov	IV	i	550
Clitocybe cerussata (Fr.) P. Kumm.	S	Nov	IV	i	570
Clitocybe dealbata (Sowerby) Gillet	S	Oct-Nov	II	d-l	200–620
Clitocybe fragrans (With.) P. Kumm.	S	Jan, Nov	IV	i-k	570–600
Clitocybe odora (Bull.) P. Kumm	S	Nov	IV	i	570
Clitocybe phyllophila (Pers.) P. Kumm.	S	Dec	I	e-h	200–560
Clitocybe rivulosa (Pers.) P. Kumm.	S	Nov	I	e-h	200–300
Conocybe filaris (Fr.) Kühner	Sl	Nov	IV	d-k-l	600
Conocybe tenera (Schaeff.) Fayod	S	Nov	I	d-k-l	600
Coprinopsis picacea (Bull.) Redhead, Vilgalys & Moncalvo	S	Nov	IV	i	570
Coprinus comatus (O.F. Müll.) Pers.	S	Jan, Apr, Oct-Nov	I-V	a-d-i	200–570
Coriolopsis gallica (Fr.) Ryvarden	Sl	Jan, Oct-Dec	I-II	d-e-f-h-i-j	200–595

Tab. 1. – continued

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Cortinarius bisporiger Contu	M	Dec	III	o	5
Crepidotus calolepis (Fr.) P. Karst.	Sl	Dec	III	o	5
Crepidotus cesatii (Rabenh) Sacc. var. *cesatii*	Sl	Jan	I	i-k	550
Crepidotus variabilis (Pers.) P. Kumm. var. *variabilis*	Sl	Oct	I	i-k	550
Crinipellis scabella (Alb. & Schwein.) Murrill	Sl	Jan-Feb, Nov-Dec	I-III	b-i-k-o	5–570
Crucibulum crucibuliforme (Scop.) V.S.	Sl	Jan, Nov-Dec	III	o	5
Daldinia concentrica (Bolton) Ces. & De Not.	Sl	Nov-Dec	I-IV-V	d-i-k	200–570
Descomyces albus (Klotzsch) Bougher & Castellano	M	Jan-Feb, Nov-Dec	III	o	5
Exidia thuretiana (Lév.) Fr.	Sl	Jan	I	d-k-l	600
Funalia trogii (Berk.) Bondartsev & Singer.	Sl	Oct	I	e-h	560
Geastrum schmidelii Vittad.	S	Dec-Jan	III	o	5–600
Genea fragrans (Wallr.) Sacc.	M(?)	Jan	IV-V	e-l	700
Geoglossum cookeanum Nannf.	S	Jan	II	d	200–300
Gloeophyllum sepiarium (Wulfen) P. Karst.	Sl	May, Sept-Nov	I	d	1092
Gymnopilus junonius (Fr.) P.D. Orton	Np	Jan, Oct-Nov	I	i-k	550
Gymnopilus sapineus (Fr.) Murrill	Np	Nov	II-V	f	550–595
Gymnopus dryophilus (Bull.) Murrill	Sh	Sept-Dec	I	d-e-f-h-i-k-l	300–1080
Helvella acetabulum (L.) Quél.	S(?)	Feb	II	d	200–300
Helvella leucomelaena (Pers.) Nannf.	S(?)	Jan-Feb	II	d	200–300
Hemimycena lactea (Pers.) Singer	S	Jan	II	d	200–300
Hydnangium carneum Wallr.	M	Nov-Feb, Apr	I-IV-V	e-h-l-o	5–700
Hygrocybe conica (Scop.) P. Kumm. var. *conica*	St	Jan	I	e-h	200–560
Hysterangium inflatum Rodway	M	Nov-Feb	I-IV-V	e-g-h-o	3–560
Infundibulicybe geotropa (Bull.) Harmaja	S	Nov	IV	i	570
Inocybe cervicolor (Pers.) Quél.	M	Jan	I	d	200–300

Tab. 1. – continued

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Inocybe dulcamara (Alb. & Schwein.) P. Kumm.	M	Oct	I	i-k	550
Inocybe geophylla (Pers.) P. Kumm. var. *geophylla*	M	Nov, Jan	IV-V	i-k	550–570
Inocybe geophylla var. *lilacina* Gillet	M	Nov	IV-V	i-k	570
Inocybe pyriodora (Pers.) P. Kumm.	M	Nov	IV-V	i-k	570
Inocybe rimosa (Bull.) P. Kumm.	M	Oct	IV-V	e-l	630
Inocybe roseipes Malençon	M	Apr	IV-V	d	815–1080
Labyrinthomyces donkii Malençon	M	Nov-Jan, Apr	I	e-l-m-n-o	2–700
Laccaria bisporigera Contu & Ballero	M	Jan	I	e-h	560
Laccaria fraterna (Cooke & Massee) Pegle	M	Nov-Feb	I	e-h-o	5–560
Laccaria laccata (Scop.) Cooke	M	Jan	I	d-i-k-l	560–600
Laccaria lateritia Malençon	M	Dec, Mar-Apr	I-II	e-f-h	350–560
Laetiporus sulphureus (Bull.) Murrill	Np	Oct	I	i-k	550
Lentinellus micheneri (Berk. & M.A. Curtis) Pegler	S	Oct	I	e-h	560
Lepiota brunneoincarnata Chodat & C. Martín	Sh	Jan	I	d	200–300
Lepiota cristata (Bolton) P. Kumm.	Sh	Dec-Jan	I	d-e-h	200–560
Lepiota forquignonii Quél.	S	Nov	I	f	515
Lepista densifolia (J. Favre) Singer & Clemençon	S	Jan	II	d	200–300
Lepista nuda (Bull.) Cooke	S	Jan-Feb	I-IV	k-n	560–600
Lepista panaeolus (Fr.) P. Karst.	S	Jan	IV	i	550
Lepista sordida (Fr.) Singer var. *sordida*	S	Nov, Jan	I-II-IV	e-h-i	560
Lepista sordida var. *lilacea* (Quél.) Bon	S	Oct-Nov	IV	i	550–610
Leucoagaricus leucothites (Vittad.) M.M. Moser ex Bon	Sh	Nov-Dec	I	e-f-h	300–620
Leucopaxillus gentianeus (Quél.) Katl.	S	Nov	IV	i	550
Leucopaxillus paradoxus (Costantin & L. M. Dufour) Boursier	S	Nov	IV	i	570
Limacella illinita (Fr.) Maire	S	Nov-Feb	III	o	5

Tab. 1. – continued

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Lycoperdon lividum Pers.	S	Oct	IV	i	550
Lycoperdon per1atum Pers.	St	Nov	II	d-l	300–620
Lyophyllum buxeum (Maire) Singer	Sh	Nov-Feb	III	o	5
Lyophyllum connatum (Schumach.) Singer	Sh	Oct	I	i-k	550
Lyophyllum decastes (Fr.) Singer	St	Nov	II	l	300–620
Lyophyllum fumosum (Pers.) P.D. Orton	S	Oct	I	e-h	560
Macrolepiota excoriata (Schaeff.) M.M. Moser	St	Nov, Jan	I-II-IV-V	e-f- h-i	550–595
Macrolepiota fuligineosquarrosa Malençon	St	Nov	II	l	550–595
Macrolepiota fuliginosa (Bar1a) Bon	St	Nov-Jan	II-III	l-o	5–500
Macrolepiota konradii (Huijsman ex P.D. Orton) M.M. Moser	Sh	Nov	II	l	350–595
Macrolepiota procera (Scop.) Singer var. *procera*	S	Nov-Dec	I	e-h	560–600
Macrolepiota rhacodes var. *bohemica* (Wichanský) Bellù & Lanzoni	S	Oct	IV	i	560
Marasmiellus ramealis (Bull.) Singer var. *ramealis*	Sl	Nov	I	b-d	650
Marasmius oreades (Bolton) Fr.	S	Oct-Nov	I-II-IV-V	f-i	300–620
Marasmius scorodonius (Fr.) Fr.	S	Jan	IV-V	e-l	700
Melanogaster ambiguus (Vittad.) Tul. & C. Tul.	M	Jan	IV-V	e-l	700
Melanoleuca melaleuca (Pers.) Murrill	S	Nov, Jan	IV	a-d-i	815–1080
Melanoleuca polioleuca (Fr.) G. Moreno	S	Nov	IV	i	570
Melanoleuca tristis M.M. Moser	S	Nov-Jan	III	o	5
Meruliopsis corium (Pers.) Ginns	Sl	Apr, Jun	I	e-h-l	350–560
Meruliopsis tremellosus Schrad.	Sl	Oct	I	e-l	630
Mycena galericulata (Scop.) Gray	Sl	Oct-Nov	I	f-i-k	300–620
Mycena galopus (Pers.) P. Kumm. var. *galopus*	S	Nov, Jan	IV	i-k	570–600
Mycena inclinata (Fr.) Quél.	Sl	Nov	I	i-k	550
Mycena pura (Pers.) P. Kumm.	S	Nov	II	l-i	350–570

Tab. 1. – continued

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Omphalotus olearius (DC.) Singer	Np	Oct	I	e-l	630
Otidea bufonia (Pers.) Boud.	M	Oct	I	e-l	630
Panaeolus acuminatus (Schaeff.) Quél.	S	Nov	IV	i	550
Panaeolus ater (J. E. Lange) Kühner & Romagn.	S	Nov	IV	i	550
Panaeolus campanulatus (L.) Quél.	S	Jan	I-IV-V	i-k	550–570
Panaeolus sphinctrinus (Fr.) Quél.	S	Oct-Nov	I-II-IV-V	f-i	300–620
Parasola megasperma (P.D. Orton) Redhead, Vilgalys & Hopple	S	Nov	III	o	5
Parasola plicatilis (Curtis) Redhead, Vilgalys & Hopple	S	Nov, Jan	IV	i	550–570
Peziza violacea Pers.	S	Jan	II	d	200–300
Phallus impudicus L.	S	Oct	I-II	e-l	630
Phellinus erectus A. David, Dequatre & Fiasson	Np	Nov	I-II-IV-V	b-d-f	300–620
Phellinus punctatus (Fr.) Pilát	Np	Oct	I	e-l	630
Phellinus torulosus (Pers.) Bourd. & Galzin	Np	Oct-Nov	I-II-V	e-f-i-k-l	550–630
Phlebiopsis ravenelii (Cooke) Hjortstam	Sl	Jul	I	d	190
Pholiota highlandensis (Peck) A.H.Sm. & Hesler	S	Nov, Jan-Feb	IV-V	d-f-i-k-l-m-n	400–592
Pisolithus arrhizus (Scop.) Rauschert	M	Oct, Dec-Jan	I	d-e-h	200–560
Plectania rhytidia (Berk.) Nannf. & Korf	S	Nov, Jan	I-III	o	5–610
Pluteus cervinus P. Kumm. var. *cervinus*	Sl	Nov	I	i-k	550
Pluteus nanus (Pers.) P. Kumm.	Sl	Nov	I	i-k	550
Pluteus romellii (Britzelm.) Lapl.	Sl	Nov, Jan	I-III	d-i-k-o	5–570
Pluteus thomsonii (Berk. & Broome) Dennis	Sl	Nov	I	i-k	570
Polyporus arcularius (Batsch) Fr.	Sl	Oct	I	i-k	570
Psathyrella candolleana (Fr.) Maire	S	Nov	IV	i	550
Psathyrella conopilus (Fr.) A. Pearson & Dennis	S	Nov-Jan	I-III	o	5–550
Psathyrella marcescibilis (Britzelm.) Singer	S	Nov	II	d	650

Tab. 1. – continued

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Psathyrella piluliformis (Bull.) P.D. Orton	S	Oct, Dec	II	d	200–300
Radiigera atrogleba Zeller	M	Jan	IV-V	e-l	700
Radulomyces confluens (Fr.) M. P. Christ.	Sl	Nov	I	i-k	610
Ramaria quercus-ilicis Schild	M	Nov	IV	d	1092
Rhodocollybia butyracea (Bull.) Lennox f. *asema* (Fr.) Antonín, Helling & Noordel.	S	Nov	I	i-k	570
Rhodocybe gemina (Fr.) Kuyper & Noordel.	S	Nov, Jan	I-V	e-h	550–600
Russula pectinatoides Peck	M	Nov	I	i-k	550
Russula torulosa Bres. var. *torulosa*	M	Oct-Nov	IV	d	815–1092
Sarcosphaera crassa (Santi) Pouzar	M	Feb-Apr	IV-V	d-m-n	592–1092
Schizophyllum commune Fr.	Sl	Jan	I	e-h	560
Schizopora paradoxa (Schrad.) Donk	Sl	Oct, Jan	I	d-e-h	200–560
Scleroderma bovista Fr.	Sl	Nov	II-V	f	350–550
Scleroderma flavidum Ellis & Everh.	M	Dec-Jan	III	o	5
Scleroderma polyrhizum (J.F. Gmel.) Pers.	M	Oct-Nov	I	i-k	540
Scleroderma verrucosum (Bull.) Pers.	M	Apr	I	i-k	610
Setchelliogaster tenuipes (Setch.) Pouzar var. *tenuipes*	M	Oct-Apr	I-III	a-d-e-g-h-i-k-l-m-o	5–750
Setchelliogaster tenuipes var. *reophyllus* (Bertault & Malençon) G. Moreno & M.P. Martin	M	Jan	I	e-h	560
Skeletocutis nivea (Jungh.) Jean Keller	Sl	Dec	I	d	200–300
Steccherinum fimbriatum (Pers.) J. Erikss.	Sl	Feb	I	b	150–300
Steccherinum ochraceum (Pers.) Gray	Sl	Dec	I	d	200–300
Stereum hirsutum (Willd.) Pers.	Sl	Jan-Dec	I-II-IV-V	d-e-f-h-i-k-l	300–1092
Stropharia coronilla (Bull.) Quél.	S	Nov, Jan	IV-V	d-k-l	600–815

Tab. 1. – continued

Taxa	Ecological category	Fructification period	Type of vegetation	Type of soil	Altitude (m)
Tapinella panuoides (Batsch) E.-J. Gilbert	Sl	Nov	IV	d	200–300
Tephrocybe atrata (L.) Donk	S	Jan	I	e-h	560–650
Thelephora terrestris Ehrh.	M	Dec	I	i-k	550
Trametes versicolor (L.) Lloyd	Sl	Oct, Dec, Feb	I	d-e-l-m-n	592–1080
Tremella mesenterica Retz.	Sl	Nov-Jan	I	b-d-i-k	150–550
Trichaptum fuscoviolaceum (Ehrenb.) Ryvarden	Sl	Nov	I	b-d	650
Tricholoma apium Jul. Schäff.	M	Oct	I	i-k	550
Tricholoma batschii Gulden	M	Nov	I	d	815–1080
Tricholoma equestre (L.) P. Kumm.	M	Nov	IV-V	i-k	570
Tricholoma scalpturatum (Fr.) Quél.	M	Feb	IV-V	m-n	592
Tricholoma sejunctum (Sowerby) Quél.	M	Nov	IV-V	i-k	570
Tricholoma terreum (Schaeff.) P. Kumm.	M	Dec	IV-V	d	200–300
Tubaria furfuracea (Pers.) Gillet	S	Jan	IV	i	550
Tubaria hiemalis Romagn. ex Bon.	S	Nov, Jan-Feb	I-II-IV-V	f	300–638
Tuber foetidum Vittad.	M	Jan	I-II-IV-V	d-k-l	750
Tuber oligospermum (Tul. & C. Tul.) Trappe	M	Feb	I-II-IV-V	m-n	592
Tuber puberulum Berk. & Broome	M	Jan, Apr	I-II-IV-V	e-l-m-n	592–700
Tuber rufum Pico	M	Jan-Feb, Apr, Jun	I-II-IV-V	e-l-m-n	592–700
Tyromyces subcaesius A. David	Sl	Dec-Jan	I	d	200–300
Volvariella gloiocephala (DC.) Boekhout & Enderle	S	Oct	IV	i	550–630

deep debate among researchers and foresters on the opportunity to maintain such ecosystems or to turn it into autochtonous broad-leaved woods is still open. In the Mediterranean area there is also a lack of ecological and mycological studies on eucalyptus woods.

In spite of the fact that eucalyptus woods are characterized by low plant diversity, a huge number of macromycetes such as saprobes and pathogens are able to colonize leaves, stumps, twigs and woods while mycorrhizal fungi do not exceed the rate of 22% of species. Moreover the composition of symbionts is quite different if compared to data coming from the Australian continent where the diversity of mycorrhizal fungi is distinctly higher (Bougher 1995). This confirms the decline of these ecosystems in Sicily and their difficulties in ecological adaptation to the pedological and climatic conditions of the island.

Seventy-nine taxa collected during our survey were also reported by Lago & Castro (2003) from eucalyptus woods in the Iberian Peninsula. On the contrary a very low number of taxa collected in Sicily were included in the lists of May & Simpson (1997) for Australia and Packham *et al*. (2002) for Tasmania.

In conclusion, according to the data available, it seems that the ecological features of the Mediterranean area prevent eucalyptus trees from maintaining the same or similar symbiotic relationships as they exhibit in their countries of origin.

Acknowledgments

This research was financially supported by the Università degli Studi di Palermo (fondi di Ateneo, ex quota 60 % 2004) in the frame of the project "L'uso dei funghi nello sviluppo sostenibile: il caso degli eucalipteti/The role of fungi in sustainable development: the case of *Eucalyptus*".

References

AA. VV. (1992) *I boschi di Sicilia*. Editrice Arbor, Palermo.

Arnolds E., Kuyper Th. W., Noordeloos M. E. (eds.) (1999) *Overzicht van de Paddestoelen in Nederland*. Nederlandse Mycologische Vereniging. 879 pp.

Basso M.T. (1999) *Lactarius* Pers. Fungi Europaei. *Mykoflora*, Alassio (Savona). 845 pp.

Bernicchia A. (2005) *Polyporaceae* s.l. *Fungi Europaei 10*. Edizioni Candusso. 808 pp.

Bougher N.L. (1995) Diversity *of ectomycorrhizal fungi associated with eucalypts in Australia.* In *Mycorrhizas for Plantation Forestry in Asia* (eds. M. Brundett *et al.*), Australian Centre for International Agricultural Research Proceedings No. 62: 8–15.

Bougher N L., Syme K. (1998) *Fungi of Southern Australia.* CSIRO, Australia.

Breitenbach J., Kränzlin F. (1984) *Champignons de Suisse* 1. *Les Ascomycètes*. Ed. Mykologia, Lucerne.

Breitenbach J., Kränzlin F. (1986) *Champignons de Suisse* 2. *Champignons sans lames. Hétérobasidiomycètes, Aphyllophorales, Gastéromycètes*. Ed. Mykologia, Lucerne.

Breitenbach J., Kränzlin F. (1991) *Champignons de Suisse* 3. *Bolets et champignons à lames. 1ère partie. Strobilomycetaceae, Boletaceae, Paxillaceae, Gomphidiaceae, Hygrophoraceae, Tricholomataceae, Polyporaceae (lamellées)*. Ed. Mykologia, Lucerne.

Breitenbach J., Kränzlin F. (1995) *Champignons de Suisse* 4. *Bolets et champignons à lames. 2eme partie. Entolomataceae, Pluteaceae, Amanitaceae, Agaricaceae, Coprinaceae, Bolbitiaceae, Strophariaceae*. Ed. Mykologia, Lucerne.

Breitenbach J., Kränzlin F. (2000) *Champignons de Suisse* 5. *Champignons à lames. 3eme partie. Cortinariaceae*. Ed. Mykologia, Lucerne.

Candusso M., Lanzoni G. (1990) *Lepiota* s.l. Libreria Editrice Giovanna Biella, Saronno. 743 pp.

Courtecuisse R., Duhem B. (1994) *Les champignons de France*. Eclectis, Paris. 448 pp.

Dennis R. W. G. (1981) British *Ascomycetes*. J. Cramer, Vaduz.

Eriksson J., Ryvarden L. (1973) *The Corticiaceae of North Europe* 2. *Aleurodiscus-Confertobasidium*. Fungiflora, Oslo, Norway.

Eriksson J., Ryvarden L. (1975) *The Corticiaceae of North Europe* 3. *Coroniciu-Hyphoderma*. Fungiflora, Oslo, Norway.

Eriksson J., Ryvarden L. (1976) *The Corticiaceae of North Europe* 4. *Hyphodermella-Mycoacia*. Fungiflora, Oslo, Norway.

Eriksson J., Hjortstam K., Ryvarden L. (1978) *The Corticiaceae of North Europe* 5. *Mycoaciella-Phanerochaete*. Fungiflora, Oslo, Norway.

Eriksson J., Hjortstam K., Ryvarden L. (1981) *The Corticiaceae of North Europe* 6. *Phlebia-Sarcodontia*. Fungiflora, Oslo, Norway.

Eriksson J., Hjortstam K., Ryvarden L. (1984) *The Corticiaceae of North Europe* 7. *Schizopora-Suillosporium*. Fungiflora, Oslo, Norway.

Fierotti G. (1988) *Carta dei suoli della Sicilia, scala 1:250.000*. Palermo, Italia.

Hjortstam K., Larsson K. H., Ryvarden L. (1987) *The Corticiaceae of North Europe. Introduction and keys* 1. Fungiflora, Oslo, Norway.

Hjortstam K., Larsson K. H., Ryvarden L. (1988) *The Corticiaceae of North Europe* 8. Fungiflora, Oslo, Norway.

Jülich W. (1989) *Guida alla determinazione dei funghi 2*. Ed. Saturnia, Trento.

Lago Álvarez M., Bougher N. L., Castro M. L. (2001) Morphological variabilità and implication for definition of taxa in the *Descolea-Setchelliogaster-Descomyces* complex. *Mycotaxon* **78**: 37–57.

Lago Álvarez M., Castro M. L. (2003) Flora micolóxica (macrobasidimicetos) do eucalipto na Peninsula Ibérica: 1880–2001. *Mykes* **6**: 3–111.

La Rocca S. (2002) Macromiceti della spiaggia di "Salinelle" (Lascari, Palermo). *Quaderni di Botanica Ambientale e Applicata* **13**: 71–74.

La Rocca S., Bazan G. (2002) Contributo alla conoscenza della micoflora delle dune costiere della Sicilia: I macromiceti di contrada "Le Macchie" (Balestrate, Palermo). *Quaderni di Botanica Ambientale e Applicata* **12** (2001): 3–12.

La Rocca S., Bazan G. (2003) Distribution of five hypogeous macromycetes strictly linked to *Eucalyptus camaldulensis* and *Acacia saligna* reforestations in Sicily. *Bocconea* **16(2)**: 1067–1082.

Martin M. P., Moreno G. (2001) Molecular data confirm *Setchelliogaster tenuipes* and *Setchelliogaster reophyllus* as *Cortinariales*. *Mycotaxon* **78**: 257–263.

May T., Simpson J. A. (1997) Fungal diversity and ecology in eucalypt ecosystems. In: *Eucalypt Ecology*: *Individuals to Ecosystems* (eds. Willimas J., Woinarski J.), Cambridge University Press, Cambridge: 246–277.

May T., Wood A. E. (1997) *Catalogue and bibliography of Australian macrofungi 1*. Basidiomycota p.p. *Fungi of Australia* **2A**. Australian Biological resources Study, Canberra.

Moggi G. (1956) Inventario delle specie del genere *Eucalyptus* esistenti in Italia. *Malpighia* **1**: 7–54.

Moser M. (1980) *Guida alla determinazione dei funghi 1*. Ed. Saturnia, Trento.

Packham J. – M., May T. W., Brown M. J., Wardlaw T. J., Mills A. K. (2002) Macofungal diversity and community ecology in mature and regrowth wet eucalypt forest in Tasmania: A multivariate study. *Annual Ecology* **27**: 149–161.

Padovan F. (1994) Mappatura dei macromiceti in Italia (Problemi cartografici). *Rivista di Micologia* **37(1)**: 59–69.

Pignatti S. (1982) *Flora d'Italia 1-3*. Edagricole, Bologna.

Ryvarden L., Gilbertson R. L. (1993–1994) *European Polypores I–II*. Fungiflora, Oslo, Norway.

Sankaran K. V., Sutton B. C., Minter D. W. (1995) A checklist of fungi recorded on *Eucalyptus*. *Mycological Papers* **170**. 376 pp.

Simeto S., Alonso R., Tiscornia S., Bettucci L. (2005) Fungal community of *Eucalyptus globulus* and *Eucalyptus maidenii* stems in Uruguay. *Sydowia* **57(2)**: 246–258.

Soil Survey Staff (1975) *Soil Taxonomy – U.S.D.A., Soil Conservation Service, Agric. Handbook 436*. Washington D.C.

Venturella G., Saitta A., Sarasini M., Montecchi A., Gori L. (2004) Contribution to the knowledge of hypogeous fungi from Sicily (S-Italy). *Flora Mediterranea* **14**: 275–284.

(Manuscript accepted 6 April 2009; Corresponding Editor: R. Pöder)