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Mycorrhizal macrofungi diversity (Agaricomycetes) from Mediterranean *Quercus* forests; a compilation for the Iberian Peninsula (Spain and Portugal)

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With 1 figure and 3 tables

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Abstract: A compilation study has been made of the mycorrhizal *Agaricomycetes* from several sclerophyllous and deciduous Mediterranean *Quercus* woodlands from Iberian Peninsula. Firstly, we selected eight Mediterranean taxa of the genus *Quercus*, which were well sampled in terms of macrofungi. Afterwards, we performed a database containing a large amount of data about mycorrhizal biota of *Quercus*. We have defined and/or used a series of indexes (occurrence, affinity, proportionality, heterogeneity, similarity, and taxonomic diversity) in order to establish the differences between the mycorrhizal biota of the selected woodlands. The 605 taxa compiled here represent an important amount of the total mycorrhizal diversity from all the vegetation types of the studied area, estimated at 1,500–1,600 taxa, with *Q. ilex* subsp. *ballota* (416 taxa) and *Q. suber* (411) being the richest. We also analysed their quantitative and qualitative mycorrhizal flora and their relative richness in different ways: woodland types, substrates and species composition. The results highlight the large amount of mycorrhizal macrofungi species occurring in these mediterranean *Quercus* woodlands, the data are comparable with other woodland types, thought to be the richest forest types in the world. We point out that the presence of genera that are very well adapted to sclerophyllous Mediterranean woodlands with a potential use in afforestation or recovery programs, or being rare species, are listed in the Regional Red List of Endangered Macromycetes. Since, these woodlands suffer heavy environmental pressure, human and climate mediated, we conclude many species are approaching a high extinction risk, and it is urgent to apply legal and management measures, both,of national (Spain and Portugal) and European governments.

Key words: mycorrhizal macrofungi, *Quercus* woodlands, diversity, affinity, conservation.

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Introduction

Approximately 20000–25000 fungi species described throughout the world are considered to be ectomycorrhizal (Rinaldi et al. 2008). Mycorrhizas have widespread occurrence among land plants and are increasingly believed to have played an important role in the successful colonization of the land by plants (see Wang & Qiu 2006, for a review), inhabiting healthy root tissues of most terrestrial plants and playing a key role in the maintenance of vegetation, contributing in a decisive way to the equilibrium and ecological stasis of most plant communities worldwide (Trappe 1996). Many ecosystems have received comparatively little attention (Comandini et al. 2006), given the ecological importance of host specificity for plant ectotrophic communities and the associated mycota (Hetrick 1984), mainly with regard to biogeochemical cycles of the major plant nutrients (Kennedy & Smith 1995).

In the present work, we studied the genus *Quercus* (see Table 1) with key species regarding structure and quantitative composition of most woodland types in the western Mediterranean (Quèzel & Barbero 1985), growing in many cases together with several Mediterranean coniferous species, both natural and planted (Pausas et al. 2004). For these important plant habitats there is no compilation available focusing on describing the mycorrhizal component, and establishing comparisons of its diversity within different *Quercus* species as hosts. The present compilation is made in the Iberian Peninsula (Spain and Portugal), where these forest types are the most widespread, being *Q. ilex s.l.* the species with the biggest potential area (Blanco et al. 1997).

Previous data, regarding the mycobiota of *Quercus* forests (e.g. Ortega & Lorite 2007, Laganá et al. 2000, 2002), suggest that there are many species of *Agaricomycetes* that form mycorrhizal associations with Mediterranean *Quercus* species.

On the other hand, throughout the Mediterranean area, these woodland types are affected negatively by climatic change, fire (wild or human-mediated), deforestation, overgrazing, desertification, changes in farming practices, a spread of human settlement for tourism, etc. (Barbero et al. 1990, López-Bermudez & Albadalejo 1990). These environmental changes are associated with reductions in belowground microbial diversity (Ferrol et al. 2004) and, because of the key ecological functions of mycorrhizal symbiosis (Jeffries & Barea 2001), loss or decline of the mycorrhizal potential in degraded areas may limit the successful reestablishment of native plants (Requena et al. 2001).

For the reasons above exposed, the aims of the work are: (i) to update the check-list of mycorrhizal macrofungi that fructifying in *Quercus* forests of Iberian Peninsula (Spain and Portugal); (ii) to analyse mycorrhizal diversity of different woodland types, dominated by *Quercus* spp. iii) to relate this mycorrhizal diversity with the diversity observed at regional scale.

Materials and methods

Study area: The Iberian Peninsula (Spain and Portugal) is located in the south-western edge of Europe, occupying about 581,300 km^2. The Peninsula is structured around the high central plateau (meseta in Spanish), surrounded by two main alpine massifs: the Pyrenees and the Baetics, both reaching more than 3,000 m (the highest being Mulhacén peak, 3,482 m). This peninsula can be divided into three general rock types: siliceous (schists, quartzites, granites, etc.), limestones, and marls. The Mediterranean part of the area occupies roughly two thirds of the whole area in the southern, central, and north-central part. It has a Mediterranean climate type with a dry summer period, with an average rainfall ranging between 150 and more than 1,500 mm per year (see Rivas Martínez & Loidi 1999a, for further details) and annual average temperature between 19°C (coastal zones in the southeastern part) and 4°C (summit areas). In phytogeographical terms, two main units have been described (Rivas-Martínez & Loidi 1999b), the first covering the western part (Portugal and central-western Spain) with predominantly siliceous rocks, and the second one formed by the eastern part (central-eastern Spain) with calcareous rocks predominating.

Collecting data: First, we compiled the information, beginning with the selection of Mediterranean species of the genus *Quercus* that inhabit the Iberian Peninsula (according Amaral-Franco 1990), discarding the species with a restricted distribution area and/or not sampled in terms of macrofungi, such as *Q. humilis* and *Q. lusitanica*. The woodland types selected were: *Q. canariensis, Q. faginea, Q. pyrenaica, Q. coccifera, Q. ilex* subsp. *ballota, Q. ilex* subsp. *ilex* and *Q. suber* (see Table 1 for further information).

Data on the association between *Quercus* spp. and ectomycorrhiza-forming fungi presented in this paper are based on reports of field observations of sporocarp associations with potential hosts. The data set contains information collected from a variety of published sources, including taxonomic monographs of specific groups of ectomycorrhizal fungal genera (e.g. *Amanita, Boletus, Cortinarius, Lactarius, Tricholoma*, hypogeous macrofungi, etc.) (Campoamor et al. 2000, Conca & Mahiques 2002, Conca & Tejedor 2005, Conca et al. 2006, Fernández & Undagoitia 2007, García & Pérez 2002, García et al. 1996, García-Alonso 2004, García-Bona 1994, Gutiérrez & Vila 2001, 2002, Heykoop & Esteve-Raventós 1994, Mahiques 1997, 1999a, 1999b, 1999c, 2001, 2002, 2004, 2006, Mahiques & Ballará 2005, Mahiques & Conca 2001, Mahiques & Ortega 1997, 2000, 2001, 2002, Mahiques & Tejedor 1999, 2001, Mahiques et al. 1995, Tejedor & Basso 2003, Tejedor & Mahiques 2001, 2003, Tejedor et al. 2004), the few previous surveys of fungi associated with selected *Quercus* species (Blanco & Moreno1986, Calonge et al. 2000, García-Bona 1989, Laganá et al. 2000, 2002), a large amount of local check-lists from the Iberian Peninsula (Conca et al. 1997, 2003, 2004, Esteve-Raventós 1987, Fernández et al. 2006, García-Bona 1987, Heykoop 1993, Heykoop & Esteve-Raventós 1994, Heykoop & Moreno 2007, Heykoop et al. 1992, Honrubia & Llimona, 1983, Llimona et al. 1995, 2000, Malençon & Bertault 1970, 1975, Malençon & LLimona 1980, Moreno & Esteve-Raventós 1988, Moreno et al. 1990, 2004a, 2004b, Moreno-Arroyo 2004, Moreno-Arroyo et al. 2005, Pérez de Gregorio 1996, Picón et al. 2004a, 2004b, Suárez et al. 2004, Undagoitia et al. 2007), as well as unpublished private collections and observations. Fungal taxa belonging to genera for which the mycorrhizal status is currently uncertain were not listed. Only records clearly mentioning (potential) *Quercus* hosts were included in the data matrix.

Data analysis: Firstly, to compare different features of the mycobiota in the studied woodlands types, different indexes were used: Occurrence-rate index (Ior) = number of species belonging to one genus present in a woodland type/total number of species of this genus inhabiting the Iberian Peninsula. Affinity index (Ia) = number of species belonging to one genus present in a woodland type/total number of species of this genus inhabiting all the *Quercus* woodlands. The first one (Ior) reflects the affinity of the genus in general terms, taking into account the whole genus, while the second one (Ia) reflects the affinity of the genus only inside the *Quercus* woodland types. Proportionality index (Ip) = number of the species belonging to one genus present in a woodland type/total number of species that inhabit a woodland type. Heterogeneity index (Ih) = number of species collected in a specific woodland type/number of species collected in all the woodland types. Similarity Jaccard index (see Magurran 2004) (Ij) = c/(a + b - c), where, a = number of species present in the woodland type A; b = number of species present in the woodland type B; c = number of species present, types A and B. Taxonomic diversity index: adapted from Margalef index (Magurran 2004) (Itd = S-1/lnN; where S = number of genera present in a specific woodland type, N = number of species present in this woodland type).

Based on the raw table of the mycorrhizal taxa and their potential hosts (see Appendix 1), we performed a presence/absence matrix (available from the authors) of mycorrhizal species (605 rows) by *Quercus* taxa studied here (7 columns) and 4 additional columns that represent siliceous, indifferent,

Table 1. Main characteristics of the studied species of the genus *Quercus* (according Amaral-Franco 1990, Schwartz 1964, Valle & Lorite 2003). [1]Bio. = Biotype (MP = Macrophanerophyte; NP = Nanophanerophyte). [2] L. type = Leaf type (Mar. = Marcescent; Scle. = Sclerophyllous). [3] Subs. = Substrate (Sil. = Siliceous; Ind. = Indifferent). [4]Alt. = Altitudinal range. [5]Therm. = Thermotype (T = Termomediterranean, M = Mesomediterranean, S = Supramediterranean). [6]Ombr. = Ombrotype (Su = Subhumid, Hu = Humid, Hy = Hyperhumid, Sa = Semiarid, D = Dry) (according Rivas-Martínez & Loidi,1999a,1999b). [7] Distribution area.

Taxa	Bio.[1]	L. type[2]	Subs.[3]	Alt.[4]	Therm.[5]	Ombr.[6]	Distrib. area[7]
Q. canariensis Willd.	MP	Mar.	Sil.	0–1000	T-M	Su-Hu	Iberian Peninsula and NW Africa
Q. coccifera L.	NP	Scle.	Ind..	0–1200	T-M	Sa-D	W Mediterranean
Q. faginea Lam.	MP	Mar.	Ind.	200–1900	T-M-S	Su-Hu	Iberian Peninsula
Q. ilex L. subsp. ilex	MP	Scle.	Ind.	0–1200	T-M	D-Su	Mediterranean Region
Q. ilex subsp. ballota (Desf.) Samp.	MP	Scle.	Ind.	0–2000	T-M-S	D-Su	Mediterranean Region
Q. pyrenaica Willd.	MP	Mar.	Sil.	400–2100	T-M-S	Su-Hy	W-SW France, Iberian Peninsula and N Africa (Morocco)
Q. suber L.	MP	Scle.	Sil.	0–1500	T-M	Su-Hy	W Mediterranean

sclerophyllous, and marcescent woodland types, respectively (see Table 1). Afterwards, we performed a matrix of genera by *Quercus* taxa (Table 2).

The relationships between the different fungal species and *Quercus* species were established by indirect-gradient analysis, namely Detrended Correspondence Analysis (hereafter DCA; Hill & Gauch 1980), using the statistical package CANOCO for Windows v4.1 (ter Braak & Smilauer 1998), with non-transformed data and down-weighting rare-species options. For this analysis *Q. coccifera* was eliminated, because it acted as an outlier, due to the scarcity of available data, even though data belonging to this species appear in Table 2.

Results

Analysis of the Mycorrhizal Mycobiota (*Agaricomycetes*) of *Quercus* forests in Spain

According to Tellería (2002), the Iberian Peninsula (Spain and Portugal) and Balearic Island have over 5000 species of *Basidiomycota*. There are 2000 catalogued species in Andalusia (Southern Spain) (Moreno-Arroyo et al. 2005). Nevertheless, other authors significantly increase this amount (e.g. Heykoop et al. 2003). Based on our own data (Ortega & Lorite 2007), we estimated that the ratio of mycorrhizal to saprotrophic species is 0.93 in the sclerophyllous woodlands of Andalusia. According to this ratio we expect in the Iberian Peninsula the number of mycorrhizal *Basidiomycota* to range between 2000 and 2300 taxa, mostly belonging to the class *Agaricomycetes*. With respect to the genera included here (see Table 2), we estimate that 1,500–1,600 taxa inhabit the Iberian Peninsula, so that the 605 taxa compiled here, corresponding only to the *Quercus* woodlands, represent a large amount of the total diversity of this genera in the study area, with *Q. ilex* subsp. *ballota* (416 taxa) and *Q. suber* (411) being the richest.

According to the data shown in Table 2 (excluding monospecific genera), we can arrange the genera into four categories, according the Affinity index (Ia): GROUP I (Ia = 0.7–1) high affinity to *Quercus* forests: *Amanita* (0.80), *Boletus* (0.78), *Cantharellus* (0.73), *Clavariadelphus* (0.75), *Gymnomyces* (1), *Hydnum* (0.75), *Laccaria* (0.80), *Scleroderma* (0.86) and *Xerocomus* (1),; GROUP II (Ia = 0.4–0.6) medium affinity to *Quercus* forests: *Hebeloma* (0.55), *Hygrophorus* (0.43), *Hymenogaster* (0.43), *Inocybe* (0.40), *Lactarius* (0.40), *Melanogaster* (0.60), *Ramaria* (0.40), *Russula* (0.45), *Sarcodon* (0.58), *Thelephora* (0.57), *Tricholoma* (0.50); GROUP III (Ia = 0.1–0.3) low affinity to Quercus forests: *Albatrellus* (0.17), *Chalciporus* (0.25), *Cortinarius* (0.25) *Gautieria* (0.20), *Gyroporus* (0.30), *Hydnellum* (0.30), *Hysterangium* (0.24) *Leccinum* (0.15), *Phellodon* (0.20), *Pseudocraterellus* (0.33), and *Zelleromyces* (0.25).

Table 2 lists the quantitative data of the different woodland types, the most meaningful being: (i) *Albatrellus* and *Leucortinarius* are represented by only one species each and they have an acidophilous behaviour; the first one grows in areas under oceanic influence (where *Q. suber* predominate), while the second predominates in areas with a more continental character (governed by *Q. pyrenaica*). (ii) Hypogean species are characterized by a high affinity to sclerophyllous woodland types over calcareous substrate, with the exception of *Hymenogaster populetorum* Tul. and *Hysterangium rickenii* Soehner, that have been collected in *Q. faginea* woodlands, as well as *Hysterangium cistophilum* (Tul. & C.Tul.) Zeller & Dodge, *H. clathroides* Vittad. and *Melanogaster variegatus* (Velen.) Tul., both collected in *Q. suber* siliceous woodlands. This fact shows that hypogean species are specialized in developing in relatively mesic areas with basic pH. (iii) Species that belong to the genera *Cortinarius*, *Hebeloma*, and *Inocybe* have a clear affinity to sclerophyllous forests as opposed to marcescent (Ia = 0.97 vs. 0.31; 1 vs. 57%; 0.94 vs. 0.47). Taxa belonging to *Cortinarius* and *Inocybe* are less frequent in siliceous woodlands (Ia = 0.92 vs. 0.61; 0.86 vs., 0.71), whereas *Hebeloma* appears equally in both types (siliceous and calcareous). Taxa of *Amanita*, *Hygrophorus*, and *Tricholoma* are significantly more frequent in sclerophyllous (Ia = 1) than the marcescent woodlands (Ia = 0.26–0.53). Nevertheless, *Laccaria* (Ia = 0.88 vs. 0.75), appears in both types due to the high ability of the species to form mycorrhizas in *Quercus* species (e.g. Tateishi et al 2003, Roy et al. 2008). On the other hand, *Hygrophorus* species are indifferent to basic pH (Ia = 0.79–0.93), *Amanita* appears equally in both types (Ia = 0.84 vs. 0.82), while *Tricholoma* (Ia = 0.75 vs. 0.83) and *Laccaria* (Ia = 0.88 vs. 1) prefer siliceous soils. (iv) The genera *Boletus*, and *Xerocomus* grow equally in all the woodland types studied. *Leccinum* shows a different behaviour, preferring marcescent and acidic woodland types. The genera *Aureoboletus* and *Gyroporus*, represented by only one species each, have a broad ecological range. *Chalciporus* and *Paxillus*, despite that data on fruit bodies in marcescent *Quercus* are not available, numerous records are available on other deciduous forest types. Gasteroid forms such as *Pisolithus* and *Scleroderma* form mycorrhizas with a broad range of tree and shrubs species (Calonge 1998), and therefore their presence in *Quercus* woodland types is not rare, even though *Scleroderma* appears to have more affinity to sclerophyllous woodlands. The case of *S. areolatum* is noteworthy, due to its specific ecological requirements, and therefore is reported only in the *Q. ilex* subsp. *ilex* woodlands in

Table 2. Number of species per genus and degree of representativeness (i.e. n° of species per genera/Total n° of species in the forest type) in forest types studied. (Qball = *Quercus ilex* subsp. *ballota*, Qil = *Q. ilex* subsp. *ilex*, Qsub = *Q. suber*, Qpyr = *Q. pyrenaica*, Qfag = *Q. faginea*, Qcoc = *Q. coccifera*, Qcan = *Q. canariensis*). [1]Qscl = sclerophyllous *Quercus* spp. (*Q. sube*r, *Q. ilex* subsp. *ballota*, *Q. ilex* subsp. *ilex* and *Q. coccifera*). [2]Qmar = marcencent *Quercus* spp. (*Q. canariensis, Q. faginea, Q. pyrenaica*). [3]Qind = Indifferent/basiphilous *Quercus* spp. (*Q. coccifera, Q. ilex* subsp. *ballota*, *Q. ilex* subsp. *ilex* and *Q. faginea*). [4]Qsil = silicicolous *Quercus* spp. (*Q. canariensis, Q. pyrenaica, Q. sube*r).

	Qball	%	Qil	%	Qsub	%	Qpyr	%	Qfag	%	Qcoc	%	Qcan	%	Qscle[1]	%	Qmar[2]	%	Qind[3]	%	Qsil[4]	%
Albatrellus	0	0.00	0	0.00	1	0.24	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	0	0.00	1	0.22
Amanita	43	10.34	15	5.21	42	10.22	15	8.77	17	9.77	4	19.05	11	10.28	51	8.85	26	8.84	43	8.37	42	9.38
Aureoboletus	1	0.24	1	0.35	1	0.24	1	0.58	1	0.57	0	0.00	1	0.93	1	0.17	1	0.34	1	0.19	1	0.22
Boletopsis	1	0.24	0	0.00	1	0.24	1	0.58	0	0.00	0	0.00	0	0.00	1	0.17	1	0.34	1	0.19	1	0.22
Boletus	25	6.01	15	5.21	22	5.35	11	6.43	17	9.77	0	0.00	6	5.61	25	4.34	23	7.82	27	5.25	25	5.58
Cantharellus	5	1.20	4	1.39	7	1.70	4	2.34	1	0.57	1	4.76	1	0.93	8	1.39	4	1.36	7	1.36	7	1.56
Chalciporus	1	0.24	0	0.00	1	0.24	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	1	0.19	1	0.22
Clavariadelphus	2	0.48	1	0.35	2	0.49	0	0.00	2	1.15	0	0.00	2	1.87	2	0.35	2	0.68	2	0.39	2	0.45
Cortinarius	94	22.60	97	33.68	86	20.92	29	16.96	30	17.24	2	9.52	11	10.28	149	25.87	48	16.33	140	27.24	93	20.76
Craterellus	1	0.24	1	0.35	1	0.24	1	0.58	1	0.57	0	0.00	0	0.00	1	0.17	1	0.34	1	0.19	1	0.22
Gauteria	1	0.24	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	1	0.19	0	0.00
Gymnomyces	4	0.96	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	4	0.69	0	0.00	4	0.78	4	0.89
Gyroporus	1	0.24	1	0.35	1	0.24	0	0.00	0	0.00	0	0.00	1	0.93	1	0.17	1	0.34	1	0.19	1	0.22
Hebeloma	12	2.88	4	1.39	11	2.68	6	3.51	8	4.60	0	0.00	4	3.74	14	2.43	8	2.72	12	2.33	12	2.68
Hydnellum	3	0.72	1	0.35	3	0.73	1	0.58	1	0.57	0	0.00	1	0.93	3	0.52	3	1.02	3	0.58	3	0.67
Hydnum	3	0.72	3	1.04	2	0.49	2	1.17	1	0.57	1	4.76	1	0.93	3	0.52	2	0.68	3	0.58	2	0.45
Hygrophorus	13	3.13	11	3.82	10	2.43	4	2.34	4	2.30	0	0.00	3	2.80	14	2.43	7	2.38	14	2.72	10	2.23
Hymenogaster	12	2.88	1	0.35	0	0.00	0	0.00	1	0.57	0	0.00	0	0.00	12	2.08	1	0.34	12	2.33	0	0.00
Hysterangium	4	0.96	0	0.00	2	0.49	0	0.00	1	0.57	1	4.76	0	0.00	4	0.69	1	0.34	4	0.78	2	0.45
Inocybe	44	10.58	32	11.11	42	10.22	19	11.11	18	10.34	2	9.52	6	5.61	62	10.76	31	10.54	57	11.09	47	10.49
Laccaria	7	1.68	2	0.69	7	1.70	6	3.51	5	2.87	1	4.76	2	1.87	7	1.22	6	2.04	7	1.36	8	1.79
Lactarius	22	5.29	21	7.29	27	6.57	15	8.77	17	9.77	4	19.05	9	8.41	33	5.73	24	8.16	30	5.84	30	6.70
Leccinum	2	0.48	2	0.69	2	0.49	2	1.17	2	1.15	0	0.00	1	0.93	2	0.35	3	1.02	2	0.39	3	0.67
Leucocortinarius	0	0.00	0	0.00	0	0.00	1	0.58	0	0.00	0	0.00	0	0.00	0	0.00	1	0.34	0	0.00	1	0.22
Melanogaster	5	1.20	0	0.00	1	0.24	1	0.58	0	0.00	0	0.00	0	0.00	5	0.87	0	0.00	5	0.97	1	0.22
Paxillus	1	0.24	1	0.35	1	0.24	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	1	0.19	1	0.22
Phellodon	0	0.00	1	0.35	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	1	0.19	0	0.00
Pisolithus	1	0.24	0	0.00	1	0.24	1	0.58	0	0.00	1	4.76	0	0.00	1	0.17	1	0.34	1	0.19	1	0.22
Pseudocraterellus	0	0.00	1	0.35	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	1	0.19	0	0.00

Table 2 continued.

	Qball	%	Qil	%	Qsub	%	Qpyr	%	Qfag	%	Qcoc	%	Qcan	%	Qscle[1]	%	Qmar[2]	%	Qind[3]	%	Qsil[4]	%
Ramaria	5	1.20	6	2.08	14	3.41	3	1.75	6	3.45	0	0.00	9	8.41	17	2.95	13	4.42	10	1.95	15	3.35
Russula	54	12.98	37	12.85	70	17.03	29	16.96	12	6.90	4	19.05	18	16.82	81	14.06	44	14.97	65	12.65	78	17.41
Sarcodon	3	0.72	2	0.69	5	1.22	2	1.17	1	0.57	0	0.00	0	0.00	6	1.04	3	1.02	4	0.78	5	1.12
Scleroderma	5	1.20	3	1.04	4	0.97	3	1.75	1	0.57	0	0.00	3	2.80	6	1.04	4	1.36	6	1.17	5	1.12
Telephora	3	0.72	0	0.00	2	0.49	0	0.00	2	1.15	0	0.00	0	0.00	3	0.52	2	0.68	4	0.78	2	0.45
Tricholoma	24	5.77	18	6.25	29	7.06	10	5.85	16	9.20	0	0.00	10	9.35	36	6.25	19	6.46	27	5.25	30	6.70
Wakefieldia	1	0.24	1	0.35	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	1	0.19	0	0.00
Xerocomus	12	2.88	6	2.08	13	3.16	4	2.34	9	5.17	0	0.00	7	6.54	16	2.78	14	4.76	14	2.72	13	2.90
Zelleromyces	1	0.24	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	1	0.17	0	0.00	1	0.19	0	0.00
Total species	416		288		411		171		174		21		107		576		294		514		448	

Italy (Laganá et al. 2002). (v) Taxa belonging to *Telephorales* (*Boletopsis, Hydnellum, Phellodon, Sarcodon*, and *Telephora*) have a broad distribution, because at least 50% of the species are present in marcescent and sclerophyllous types, as well as any soil type. Nevertheless, this group appears to be an efficient symbiont of *Quercus s.l* (Calonge 1998). The exception are taxa belonging to genus *Phellodon*, which grow only on *Q. ilex* subsp. *ilex* calcareous woodlands in the northern Iberian Peninsula (Basque country). (vi) *Cantharellus* and *Hydnum* have a similar behaviour since they clearly prefer sclerophyllous types; nevertheless, with respect to soil type, *Hydnum* species are more frequent in *Q. ilex sensu lato* woodlands (basophilous or indifferent to the pH of the soil) against *Q. suber* (siliceous soils) (Ia = 1 vs. 0.67), while *Cantharellus* grows in both soil types (calcareous and siliceous) although it is found more frequently in cork-oak woodlands (Ia = 0.88 vs. 0.64). The genera *Craterellus* and *Pseudocraterellus* are represented by only one species. The former grows in any woodland type, while the second one only on *Q. ilex* subsp. ilex (Laganá et al. 2000). (vii) Club fungi (*Clavariadelphus*) and coral fungi (*Ramaria*) appear in any *Quercus* forest, though *Ramaria* species prefer a high level of oceanicity and siliceous substrates, such as cork-oak forests, where 79% of the species here compiled occur. Some species are typical of Mediterranean environments (e.g. *Ramaria mediterranea* Schild & Franchi). (viii) *Lactarius* and *Russula* have a different ecological profile, even though the former fructifies indifferently on either calcareous or siliceous substrates, and more frequently in sclerophyllous woodlands (Ia = 0.89 vs. 0.65), while *Russula* taxa have a high level of affinity to these sclerophyllous forests (Ia = 0.91 vs. 0.49), and relatively more affinity to siliceous substrates (Ia = 0.89 vs. 0.78). For this reason, they are highly represented in *Q. suber* woodlands (70%).

Mycorrhizal mycobiota of sclerophyllous vs. deciduous *Quercus* forests

Diversity of mycorrhizal macrofungi of sclerophyllous woodlands (576 taxa, 95.2%) is higher than the marcescent types (294 taxa, 48.6%). On the one hand, sclerophyllous forests have a larger occupation and potential area in the Mediterranean biome of the Iberian Peninsula, in comparison to temperate one and for this reason there are more works regarding sclerophyllous woodland types, even though the sampling effort is similar in both types, given the lower area of the marcescent types.

Physiognomic aspects of mycobiota in a given plant community can be expressed depending on the proportionality index (Ip) of each genus that occurs in the mycobiota. With respect to the most diverse genera (in terms of species richness), we can point out the following features: *Cortinarius* is more represented in sclerophyllous woodlands (Ip = 0.26 vs. 0.16), since *Q. ilex* subsp. *ilex* (Ip = 0.34), *Q. ilex* subsp. *ballota* and *Q. suber* (Ip > 0.20) woodlands are quite rich in species belonging to these genera in comparison with marcescent types. *Boletus* (Ip = 0.43 vs. 0.78), *Lactarius* (0.57 vs. 0.82), *Ramaria* (Ip = 0.3 vs. 0.44) and *Xerocomus* (Ip = 0.28 vs. 0.47) present the opposite, since, despite the number of species being similar in both types, the Ip index is higher in marcescent.

The degree of heterogeneity (Ih) of mycorrhizal mycobiota is Ih = 0.51, in sclerophyllous as opposed to Ih = 0.65 in marcescent woodlands. Therefore, *Q. canariensis*, *Q. faginea*, and *Q. pyrenaica* woodlands have a higher degree of heterogeneity, due to a higher diversity of ecological niches occupied by marcescent *Quercus*, while *Q. coccifera*, *Q. ilex s.l.*, and *Q. suber* are more ecologically homogeneous (Sánchez de Dios et al. 2009), and more suitable for the development of Mediterranean mycorrhizal *Agaricomycetes*.

The degree of similarity (in terms of Jaccard's similarity index = Ij) is an important feature. The value of the index (Ij = 0.438), shows differences between the mycobiota of marcescent and sclerophyllous forests. Nevertheless, we should take into account that the number of collected species in each type is very different (576 vs. 294), causing a low Ij value.

Mycobiota of siliceous vs. indifferent-basophilous *Quercus* forests

The entire number of species reported in siliceous woodland types (448 taxa, 74.05%) is lower than the basophilous (514, 84.96%). The Proportionality index is very similar in *Cortinarius* (Ip = 0.21 vs. 0.27) and higher in siliceous woodlands for *Russula* (Ip = 0.17 vs. 0.13), due to the the high richness in these forest types (*Q. suber*: 70 taxa, 17.03% and *Q. pyrenaica*: 29 taxa, 16.96%).

The degree of heterogeneity is higher (Ih = 0.65) in woodlands dominated by species preferring siliceous soils than in woodlands where key species are indifferent in any preference of soil types. (Ih = 0.57). The explanation is the higher ecological heterogeneity within this second type (i.e. between *Q. canariensis*-*Q. suber* or -*Q. pyrenaica*; see Table 1) (Sánchez de Dios et al. 2009).

The similarity index (between siliceous and indifferent-basophilous; Ij = 0.577) has an important analytic value, since a high number of species have been collected in both types (448 siliceous vs. 524 indifferent-basophilous). The most significant differences refer to the genus *Cortinarius* (140 species vs. 93 species), *Hygrophorus* (14 vs. 10), *Hymenogaster* (12 vs. 0) or *Inocybe* (57 vs. 47). Hence, the majority of the taxa belonging these genera fructify on *Q. ilex s.l.*, because they are basophilous or indifferent with respect to the substrate, contrary the genera *Ramaria* (10 vs. 15) or *Russula* (65 vs. 78) are more frequent over *Q. suber*, therefore they are silicicolous (Ortega & Lorite 2007, Moreno et al. 2004)

Comparative study of different types of *Quercus* forests

DCA establishes a preliminary separation between the mycobiota of sclerophyllous and marcescent woodlands (Fig. 1) in the first axis (44,8% of the variance), while siliceous and indifferent-basophilous showed less distance. Consequently the results show that the factor related with leaf character (related with the more or less mesophilous character) is the main explanatory feature. We also point out the considerable distance between *Quercus ilex* subsp. *ballota* and *Quercus ilex* subsp. *ilex,* despite they are closely taxonomically related taxa.

To show the diversity of each woodland type, we note the degree of mycological diversity, based in the Margalef taxonomic-diversity index (Itd), as well as the number of species and genera specific of each woodland type compared with the total number

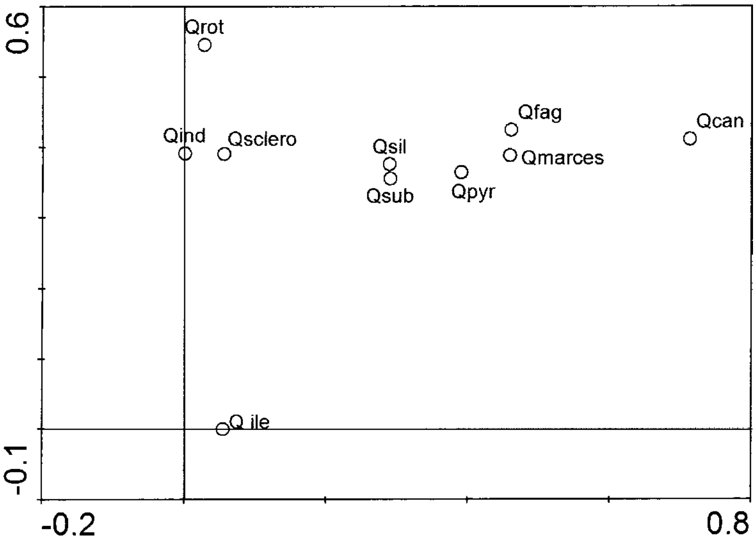

Fig. 1. Biplot showing the DCA ordination of the *Quercus* forests studied here, based on the presence-absence data of the micorrhizal taxa. Qrot = *Quercus rotundifolia*(= *Q. ilex* subsp. *ballota*), Qil = *Q. ilex* subsp. *ilex*, Qsub = *Q. suber*, Qpyr = *Q. pyrenaica*, Qfag = *Q. faginea*, Qcan = *Q. canariensis*). Qsclero = sclerophyllous *Quercus* spp. (*Q. suber*, *Q. ilex* subsp. *ballota*, *Q. ilex* subsp. *ilex*). Qmarces = marcencent *Quercus* spp. (*Q. canariensis, Q. faginea, Q. pyrenaica*). Qind = Indiferent/basiphilous *Quercus* spp. (*Q. ilex* subsp. *ballota*, *Q. ilex* subsp. *ilex* and *Q. faginea*). Qsil = silicicolous *Quercus* spp. (*Q. canariensis, Q. pyrenaica, Q. suber*).(see table 1 for further information on the taxa).

(all the *Quercus* woodland types together). The data gathered in the Table 3 reflect that the taxonomic diversity of the *Quercus* woodlands analysed here is Itd = 5.63. This is close to the value of the sclerophyllous (Itd = 5.67) and siliceous woodlands (Itd = 5.61). Since this index is strongly influenced by the number of genera and species in each woodland type, and three different woodland types have different sampling effort, we corrected the index by calculating and comparing the index with the value of the index for all the *Quercus* woodlands studied here (Table 3). The most remarkable results are: (i) sclerophyllous (Itd/Itdt) = 1.01), siliceous (Itd/Itd = 1) and holm-oak woodlands (*Q. ilex* subsp. *ballota)* (Itd/Itdt = 1.03) are the most diverse, especially in woodlands over siliceous substrates, since these woodland types have a lower number of species than the woodlands over calcareous substrates. (ii) The *Q. ilex* subsp. *ilex* woodlands present a relative high diversity (Itd = 4.74), comparable with other woodland types with a higher number of species (e.g. *Q. suber*). One explanation is the importance of some genera, especially rich, such as *Cortinarius* in these types. (iii) Marcescent woodlands are highly diverse, given the lower number of species reported, due to the major differences between the ecological features of the species included in this group, and the most suitable habitat for the macrofungi that they constitute.

Table 3. Margalef taxonomic-diversity index (Itd) for the different forest types. Itd/Itdt = quotient between the values of Margalef index for the woodland type and for the total data, respectively. Nsp/Nspt = quotient between species in the particular woodland type/species of the all woodland types studied. Ng/Ngt = quotient between genera in the particular woodland type/genera of the all woodland types studied.

Type	Itd	Itd/Itd_t	Nsp/Nspt	Ng/Ngt
Q. canariensis	4.07	0.72	0.18	0.54
Q. coccifera	3.29	0.58	0.03	0.27
Q. faginea	4.26	0.76	0.29	0.62
Q. ilex subsp. *ilex*	4.74	0.84	0.48	0.73
Q. ilex subsp. *ballota*	5.47	0.97	0.69	0.92
Q. pyrenaica	4.47	0.79	0.28	0.65
Q. suber	4.82	0.86	0.68	0.81
sclerophyllous	5.67	1.01	0.95	1.00
indifferent	5.08	0.90	0.85	0.97
siliceous	5.61	1.00	0.74	0.86
Quercus (all the types)	5.63	1.00	1.00	1.00

Discussion

The considerable number of mycorrhizal macrofungi species reported in the present work (605 taxa) highlight that *Quercus* woodlands of the study area have surprising richness, comparable with data recorded for *Eucalyptus* in natural environments of Australia (Castellano & Bougher 1994), estimated at some 660 fungal associates and believed to have the potential to associate with the richest flora of host genus-specific ectomycorrhizal fungi in the world (Molina et al. 1992).

The mycobiota have a medium affinity to the *Quercus* species, so that, together with macrofungi specific to these woodland types, such as *Amanita* spp., *Boletus* spp., hypogeous species, and some species of *Cortinarius* and *Hygrophorus*, there is a significant number of taxa with a broad distribution (e.g. some *Cortinarius* species, *Pisolithus arhizus*, *Scleroderma* spp. *Gyroporus castaneus*, *Phellodon* spp.).

The main factor determining the mycorrhizal mybiota is the woodland type (sclerophyllous *vs*. deciduous), while the pH of the soil plays a secondary role. This is reasonable, because in woodland types many underlying ecological factors determine the appearance of the mycobiota, and these results agree with the data gathered for macrofungi (both mycorrhizal and saprophytic) for the southern Spain (Ortega & Lorite 2007).

According the results, sclerophyllous woodlands are taxonomically more diverse than are the marcescent ones, whereas fungi preferring siliceous soils are more diverse than than those preferring calcareous or indifferent soils (see Results section). These results also follow the trend found for the the whole of macrofungi (Ortega & Lorite 2007).

From the detailed list of mycorrhizal taxa compiled here, we emphasize the presence of genera that are very well-adapted to the sclerophyllous Mediterranean woodlands, such as *Amanita*, *Boletus*, *Xerocomus*, *Hygrophorus*, hypogeous species, *Scleroderma*, and *Pisolithus* (see appendix 1 to check the species of these genera). Therefore, many species are appear as suitable for inoculating plants in afforestation or recovery programs, since it is well known that they significantly improve both survival and growth (e.g. Jeffries & Barea 2001).

Another aspect to highlight is the considerable number of rare species that appears in the Iberian *Quercus* woodlands. In this sense, many species included in the present compilation are present in regional Red List of Endangered Macromycetes (Brandrud et al. 2006, Gyosheva et al. 2006, Holec & Beran 2006, Lizon et al. 2001, Senn-Irlet et al. 2007), such as: *Amanita caesarea*, *A. franchetii*, *A. ovoidea*, *A. verna*, *Boletopsis leucomelaena*, *Boletus fechtneri*, *B. regius*, *B. rhodopurpureus*, *B. rhodoxanthus*, *B. satanas*, *Cantharellus melanoxeros*, *Clavariadelphus pistillaris*, *Cortinarius bulliardi*, *C. caerulescens*, *C. cagei*, *C. ionochlorus*, *C. prasinus*, *C. salor*, *C. xanthophyllus*, *Gyroporus castaneus*, *Hydnellum concrescens*, *H. scrobiculatum*, *Hydnum albidum*, *Hygrophorus arbustivus*, *Inocybe adaequata*, *I. bresadolae*, *I. corydalina*, *Lactarius acerrimus*, *L. acris*, *L. evosmus*, *L. luridus*, *Phellodon niger*, *Ramaria aurea*, *R. botrytis*, *R. flavescens*, *R. flavobrunescens*, *Russula albonigra*, *R. maculata*, *R. roseipes*, *Sarcodon leucopus*, *S. scabrosus*, *Tricholoma acerbum*, *T. sulphurescens*, *T. ustaloides*, *Xerocomus armeniacus*, and *X. moravicus*. These mycorrhizal taxa of *Quercus* woodlands appear to undergo heavy environmental pressures, human and climate mediated (Sala et al. 2000), which represent a high risk for their conservation.

In conclusion, many species are under a high extinction risk (see list above), and is urgent to apply legal and management measures, of both national (Spain and Portugal) and European governments, in order to preserve the species as well as the most appropriate structure of the forest, in order to facilitate the development of mycorrhizal taxa, that play a key role in the health and maintenance of the Mediterranean woodlands.

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Appendix 1. Presence/absence matrix of the compiled taxa by *Quercus* forest types. (Qball = *Quercus ilex* subsp. *ballota*, Qil = *Q. ilex* subsp. *ilex*, Qsub = *Q. suber*, Qpyr = *Q. pyrenaica*, Qfag = *Q. faginea*, Qcoc = *Q. coccifera*, Qcan = *Q. canariensis*).

	Qball	Qil	Qsub	Qpyr	Qfag	Qcoc	Qcan
Albatrellus subrubescens (Murrill) Pouzar	0	0	1	0	0	0	0
Amanita baccata (Fr.) Gillet	1	0	1	1	0	1	0
Amanita battarrae (Boud.) Bon	1	1	1	0	1	0	0
Amanita beillei (Beauseign.) Bon & Contu	1	0	0	0	0	0	0
Amanita caesarea (Scop.) Fr.	1	1	1	1	1	1	1
Amanita citrina var. *citrina* (Schaeff.) Pers.	1	1	1	1	1	0	1
Amanita citrina var. *alba* (Gillet) E.-J.Gilbert	0	0	1	0	0	0	0
Amanita codinae (Maire) Bertault	1	0	1	0	0	0	0
Amanita crocea (Quél.) Singer	1	1	1	0	1	0	1
[1]*Amanita curtipes* E.-J.Gilbert	1	0	1	0	0	0	0
Amanita decipiens (Trimbach) Jacquet.	1	0	1	0	0	0	0
Amanita echinocephala (Vittad.) Quél.	1	0	0	0	1	0	0
Amanita eliae Quél.	1	0	1	0	0	0	0
Amanita franchetii (Boud.) Fayod	1	0	1	1	1	0	1
Amanita fulva (Schaeff.) Fr.	0	0	1	1	0	0	0
Amanita gemmata (Fr.) Bertill.	1	1	1	1	1	0	0
Amanita gemmata fo. *amici* (Gillet) E.-J.Gilbert	1	0	1	0	0	0	0
Amanita gilbertii Beauseign.	1	0	1	0	0	0	0
Amanita gracilior Bas & Honrubia	1	0	1	0	1	0	0
Amanita lactea Malençon, Romagn. & D.A.Reid	1	0	1	0	0	1	0
Amanita lepiotoides Barla	1	0	0	0	0	0	0
Amanita lividopallescens (Secr. ex Boud.) . Kühner & Romagn	1	0	1	0	1	0	0
Amanita magnivolvata Aalto	0	0	1	0	0	0	0
Amanita mairei Foley	1	0	1	0	1	1	0
Amanita malleata (Piane ex Bon) Contu	1	1	1	0	1	0	1
Amanita muscaria (L.) Lam.	1	0	1	1	1	0	0
Amanita ovoidea (Bull.) Link	1	1	0	0	1	0	0
Amanita ovoidea var. *proxima* (Dumée) Bon & Courtec.	1	0	1	0	0	0	0
Amanita pachyvolvata (Bon) Krieglst.	1	1	1	0	0	0	0
Amanita pantherina (DC.) Krombh.	1	1	1	1	1	0	0
Amanita phalloides (Vaill.) Link	1	1	1	1	1	0	1
Amanita asteropus Sabo	1	0	1	0	0	0	0
Amanita ponderosa Malençon & R. Heim	1	0	1	0	0	0	0
Amanita porphyria Alb. & Schwein.	1	0	0	0	0	0	0
Amanita oblongospora Contu	1	0	0	0	0	0	0
Amanita rubescens Pers.	1	1	1	1	1	0	1
Amanita separata Contu	1	0	0	0	0	0	0
Amanita singeri Bas	1	0	1	0	0	0	0
Amanita spissa (Fr.) P.Kumm.	0	0	1	1	0	0	1
Amanita spissa var. *excelsa* (Fr.) Dörfelt & I.I.Roth	1	1	1	1	0	0	0
Amanita spissa var. *valida* (Fr.) E.-J.Gilbert	0	0	1	0	0	0	0
Amanita spreta (Peck) Sacc.	0	0	1	0	0	0	0
[2]*Amanita strangulata* (Fr.) Quél.	1	0	1	1	0	0	1
Amanita strobiliformis (Paulet ex Vittard.) Bertill.	1	1	1	0	1	0	0
Amanita submembranacea var. *griseoargentea* Contu	0	0	1	0	0	0	0

Amanita supravolvata Lanne	1	0	0	0	0	0	0
[3]*Amanita umbrinolutea* (Secr. ex Gillet) Bertill	1	0	1	1	0	0	0
Amanita vaginata (Bull.) Lam.	1	1	1	0	0	0	1
Amanita vaginata var. *alba* Gillet	0	0	1	0	0	0	0
[4]*Amanita valens* (E.-J.Gilbert) Bertault	1	0	1	1	0	0	0
Amanita verna (Bull.) Lam.	1	1	0	0	0	0	0
Amanita vittadini (Moretti) Sacc.	1	0	1	0	0	0	1
Aureoboletus gentilis (Quél.) Pouzar	1	1	1	1	1	0	1
Boletopsis leucomelaena Pers.	1	0	1	1	0	0	0
Boletus aereus Bull.	1	1	1	1	1	0	0
[5]*Boletus aestivalis* (Paulet) Fr.	1	0	1	1	1	0	0
Boletus apendiculatus Schaeff.	1	1	1	1	1	0	0
Boletus calopus Pers.	1	1	0	0	1	0	0
Boletus edulis Bull.	1	1	1	0	1	0	1
Boletus erythropus Pers.	1	1	1	1	1	0	0
Boletus fetchneri Velen.	1	1	0	0	0	0	0
Boletus fragrans Vittad.	1	0	1	0	0	0	1
Boletus impolitus Fr.	1	0	1	0	1	0	0
Boletus legaliae Pilát	1	0	1	0	0	0	0
Boletus lupinus Fr.	1	1	1	0	1	0	0
Boletus luridus Schaeff.	1	1	1	1	1	0	1
Boletus luteocupreus Bertéa & Estadés	0	0	0	0	1	0	0
Boletus piperatus Bull.	0	0	0	1	0	0	0
Boletus permagnificus Pöder	1	0	1	1	0	0	0
Boletus pseudoregius (Heinr. Hubert) Estades	1	0	1	0	1	0	0
Boletus pulchrotinctus Alessio	1	1	0	0	0	0	0
Boletus pulverulentus Opat.	1	1	1	1	0	0	1
Boletus queletii Schulzer	1	1	1	0	1	0	1
[6]*Boletus queletii* var. *lateritius* (Bres. & Schulz.) E.-J.Gilbert	0	0	1	1	0	0	0
Boletus radicans Pers.	1	1	1	0	1	0	0
Boletus regius Krombh.	1	1	1	0	1	0	0
Boletus rhodopurpureus Smotl.	1	0	0	1	1	0	0
Boletus rhodoxanthus (Krombh.) Kallenb.	1	1	1	0	1	0	0
Boletus satanas Lenz	1	1	1	0	1	0	0
Boletus spretus Bertéa	1	0	1	0	0	0	1
Boletus venturii Bon	1	0	1	0	0	0	0
Cantharellus cibarius Pers.	1	1	1	1	1	0	0
Cantharellus cibarius var. *alborufescens* Malençon	1	0	1	0	0	0	0
Cantharellus cinereus Fr.	0	1	1	0	0	0	0
[7]*Cantharellus ferruginascens* P.D.Orton	1	0	0	0	0	1	0
Cantharellus lutescens Fr.	0	1	1	1	0	0	1
Cantharellus melanoxeros Desm.	0	0	1	1	0	0	0
Cantharellus subpruinosus Eyssart. & Buyk	1	0	1	1	0	0	0
Cantharellus tubaeformis Fr.	1	1	1	0	0	0	0
Chalciporus piperatus (Bull.) Bataille	1	0	1	0	0	0	0
Clavariadelphus flavoinmaturus R.H.Petersen	1	1	1	0	1	0	1
Clavariadelphus pistillaris (L.) Donk	1	0	1	0	1	0	1
Cortinarius albidodiscus Bidaud & Fillion	0	1	0	0	0	0	0
Cortinarius acetosus (Velen.) Melot	0	1	0	0	0	0	0
Cortinarius acutus (Pers.) Fr.	0	1	0	0	0	0	0
Cortinarius alboviolaceus (Pers.) Fr.	1	0	0	0	1	0	0
[8]*Cortinarius alcalinophilus* Rob.Henry	1	1	1	0	1	0	1
Cortinarius aleuriosmus Maire	1	1	1	0	0	0	0
Cortinarius ammoniacosplendens Chevassut & Rob.Henry	1	0	0	0	1	0	0

	Qball	Qil	Qsub	Qpyr	Qfag	Qcoc	Qcan
Cortinarius amoenolens Rob.Henry & P.D.Orton	0	0	1	0	0	0	0
Cortinarius anfractoides Rob. Henry & Trescol	0	1	0	0	0	0	0
Cortinarius anomalus (Fr.) Fr.	1	1	1	1	1	0	0
[9]*Cortinarius anserinus* (Velen.) Rob. Henry	0	1	0	0	0	0	0
Cortinarius aprinus Melot	1	1	1	0	1	0	0
Cortinarius assiduus Mahiques, A.Ortega & Bidaud	1	1	0	0	0	0	0
[10]*Cortinarius atrovirens* Kalchbr.	0	1	0	0	0	0	0
[11]*Cortinarius aurilicis* Chevassut & Rob.Henry	1	0	0	0	1	0	0
Cortinarius aurantioturbinatus J.E.Lange	0	1	0	0	0	0	0
Cortinarius balteatocumatilis Rob.Henry ex P.D.Orton	1	0	1	0	1	0	0
Cortinarius balteatocumatilis var. *laetus* (M.M.Moser) Quadr.	0	0	1	0	0	0	0
[12]*Cortinarius boudieri* Rob.Henry	0	0	1	0	1	0	0
Cortinarius bovinus Fr.	1	0	1	0	0	0	0
[13]*Cortinarius brunneus* Pers. *sensu* J.E.Lange	0	1	0	0	0	0	0
Cortinarius bulliardi (Pers.) Fr.	1	1	1	0	1	0	1
Cortinarius caerulescens (Schaeff.) Fr.	1	1	1	1	1	0	1
[14]*Cortinarius coerulescentium* Rob.Henry	1	1	0	0	0	0	0
Cortinarius caesiocortinatus subsp. bulbolatens (Chevassut & Rob. Henry) Melot	1	0	0	0	0	0	0
Cortinarius caesiostramineus Rob.Henry	1	0	1	0	0	0	0
Cortinarius caesiostramineus var. *gentianeus* (Bidaud) A.Ortega & Mahiques	0	0	1	0	0	0	0
Corinarius cagei Melot	0	1	1	1	0	0	0
Cortinarius caligatus Malençon	1	1	1	1	0	0	0
Cortinarius calochrous (Pers.) Gray *sensu lato*	1	1	1	0	0	0	0
Cortinarius candelaris Fr.	0	1	0	0	0	0	0
Cortinarius caninus (Fr.) Fr.	1	0	1	0	0	0	0
Cortinarius caperatus (Pers.) Fr.	0	0	0	1	0	0	0
[15]*Cortinarius caroviolaceus* P.D.Orton	0	1	0	0	0	0	0
Cortinarius catharinae Cons.	1	1	0	0	0	0	0
Cortinarius causticus Fr.	0	1	1	0	0	0	0
Cortinarius cedretorum Maire	1	1	1	0	0	0	0
Cortinarius cephalixus Secr. ex Fr.	0	0	1	0	0	0	0
Cortinarius chevassutii Rob.Henry	1	1	0	0	0	0	0
Cortinarius cinnabarinus Fr.	0	0	0	1	0	0	0
Cortinarius cinnamomeus (L.) Fr.	1	1	1	0	0	0	0
Cortinarius cistoadelphus (G.Moreno & al.) G.Moreno	1	0	1	0	0	0	0
Cortinarius claroflavus Rob.Henry	1	0	0	0	0	0	0
Cortinarius claricolor (Fr.) Fr.	1	0	0	0	0	0	0
Cortinarius colus Fr.	0	0	1	0	0	0	0
Cortinarius cotoneus Fr.	1	1	1	0	0	0	0
Cortinarius croceocoeruleus (Pers.) Fr.	1	1	1	0	0	0	0
Cortinarius croceus (Schaeff.) Gray	1	0	1	0	0	0	0
Cortinarius crystalinus Fr.	0	1	0	0	0	0	0
Cortinarius cumatilis Fr.	0	1	1	1	0	0	0
Cortinarius damascenus Fr.	1	0	1	0	0	0	0
Cortinarius decipiens (Pers.) Fr.	1	1	1	1	1	0	0
[16]*Cortinarius decipiens* var. *subturibulosus* (Kizlik & Trescol) A.Ortega & Mahiques	1	0	0	0	0	0	0

Cortinarius delaportei Rob.Henry	0	1	1	0	0	0	0
Cortinarius delibutus Fr.	1	1	0	0	0	0	0
Cortinarius depallens (M.M.Moser) Bidaud, Moënne-Locc. & Reumaux	0	1	1	0	0	0	0
Cortinarius diabolicoides Moënne-Locc. & Reumaux	1	0	1	0	0	0	0
Cortinarius diabolicus (Fr.) Fr.	1	0	1	0	1	0	0
Cortinarius dibaphus Fr.	1	1	0	0	0	0	0
Cortinarius dionysae Rob.Henry	1	1	1	0	0	0	0
Cortinarius diosmus Kühner	1	1	1	0	0	0	0
Cortinarius diosmus var. *araneosovolvatus* Bon & Gaugé	1	1	1	0	0	0	0
[17]*Cortinarius duracinus* Fr.	1	1	1	1	0	0	0
[18]*Cortinarius elegantior* var. *quercus-ilicis* Chevassut & Rob.Henry	1	1	0	0	0	0	0
Cortinarius elegantissimus Rob.Henry	0	1	0	0	0	0	0
Cortinarius emollitus Fr.	0	0	1	1	0	0	0
Cortinarius eufulmineus Rob.Henry	0	1	0	0	0	0	0
Cortinarius evernius (Fr.) Fr.	0	0	1	0	0	0	0
Cortinarius flavescentium Rob.Henry	0	0	1	0	0	0	0
Cortinarius flexipes (Fr.) Fr.	0	1	0	0	0	0	0
Cortinarius conico-obtusarum A.Ortega & Chevassut	1	0	1	0	0	0	0
Cortinarius fulgens sensu Lange	0	1	0	0	0	0	0
*Cortinarius fulmineus (*Fr.) Fr.	1	1	1	0	0	0	0
Cortinarius glandicolor (Fr.) Fr.	0	1	0	0	0	0	0
Cortinarius glaucopus (Schaeff.) Fr.	1	1	1	0	0	0	0
Cortinarius hillieri Rob.Henry	0	1	0	0	0	0	0
Cortinarius hinnuleus Fr.	1	1	1	0	0	0	0
Cortinarius humolens Brandrud	1	0	1	1	1	0	0
Cortinarius infractemmatus Chevassut & Rob.Henry	1	0	0	0	0	0	0
Cortinarius infractus (Berk.) Fr.	1	1	1	1	1	0	1
Cortinarius ionochlorus Maire	1	1	0	1	1	0	0
Cortinarius joguetii Melot	0	1	0	0	0	0	0
Cortinarius lebretoni Quél.	1	0	0	0	0	0	0
Cortinarius lividoochraceus (Berk.) Berk.	1	1	1	1	1	0	1
Cortinarius maculosus (Pers.) Fr.	0	1	0	0	0	0	0
Cortinarius majusculus Kühner	0	1	0	0	0	0	0
Cortinarius maxistriatulus Rob.Henry	1	0	1	0	0	0	0
Cortinarius melanotus Kalchbr.	0	1	0	0	0	0	0
Cortinarius moënne-loccozii Bidaud	1	1	0	0	1	0	0
Cortinarius mucifluus Fr.	1	0	1	0	0	0	0
Cortinarius mucosus (Bull.) Cooke	1	1	0	0	0	0	0
Cortinarius nanceiensis Maire	0	1	0	0	0	0	0
Cortinarius nanceiensis var. *bulbopodius* Chevassut & Rob.Henry	0	1	0	0	0	0	0
Cortinarius nemorensis (Fr.) J.E.Lange	1	1	1	1	0	0	0
Cortinarius obtusus (Fr.) Fr.	1	1	1	0	0	0	0
Cortinarius olearioides Rob.Henry	1	0	1	0	1	0	0
Cortinarius olidivolvatus Bon & Trescol	0	1	1	0	0	0	0
Cortinarius olidus J.E.Lange	0	1	1	1	0	0	0
Cortinarius olivascentium Rob.Henry	0	1	1	0	0	0	0
Cortinarius olivellus Rob.Henry	0	1	0	0	0	0	0
[19]*Cortinarius orellanoides* Rob.Henry	0	1	0	0	0	0	0
Cortinarius orellanus Fr.	0	0	1	0	1	0	0
Cortinarius orichalceus (Batsch) Fr.	1	0	1	0	0	0	0

	Qball	Qil	Qsub	Qpyr	Qfag	Qcoc	Qcan
Cortinarius pachypus M.M.Moser	1	0	0	0	0	0	0
Cortinarius parafulmineus Rob.Henry	0	1	0	0	0	0	0
Cortinarius parasuaveolens (Bon & Trescol) Bidaud, Moënne-Locc. & Reumaux	1	0	0	0	0	0	0
Cortinarius petroselineus Chevassut & Rob.Henry	1	1	1	1	0	0	0
Cortinarius porphyropus (Alb. & Schwein.) Fr.	1	0	1	0	0	0	0
Cortinarius prasinus (Schaeff.) Fr.	1	0	0	0	0	0	0
Cortinarius purpurascens Fr.	1	1	1	0	1	0	1
Cortinarius rigens (Pers.) Fr.	1	1	1	1	0	0	1
Cortinarius roberti-henrici Contu	0	0	1	0	0	0	0
Cortinarius rubicundulus (Rea) A.Pearson	0	1	0	0	0	0	0
Cortinarius rubricosus (Fr.) Fr.	0	0	1	0	0	0	0
Cortinarius rufoolivaceus (Pers.) Fr.	1	1	1	1	1	0	1
Cortinarius rugosus Rob.Henry	0	1	1	0	0	0	0
Cortinarius safranopes Rob.Henry	0	1	0	0	0	0	0
Cortinarius salor Fr.	1	1	1	0	0	0	0
Cortinarius saporatus Britzelm.	1	0	1	1	0	0	0
Cortinarius scobinaceus Malençon & Bertault	1	0	1	1	1	0	0
Cortinarius sciophyllus Fr.	1	0	0	0	0	0	0
Cortinarius sertipes Kühner *sensu* A.Ortega & Mahiques	1	0	1	0	0	0	0
Cortinarius sodagnitus Rob.Henry *sensu lato*	1	0	0	1	1	0	0
Cortinarius sordescens Rob.Henry	0	1	0	0	0	0	0
Cortinarius splendens var. *meinhardii* (Bon) Melot	1	0	1	0	0	0	0
Cortinarius splendens var. *splendens* Rob.Henry	1	1	1	0	0	0	0
Cortinarius splendificus Chevassut & Rob. Henry	0	1	0	0	0	0	0
Cortinarius stillatitius Fr.	1	0	1	0	0	0	0
Cortinarius strenuipes var. *subacuminatus* Rob.Henry ex Reumaux	0	0	0	1	0	0	0
Cortinarius strenuisposus Bidaud, Cors. Gut. & Vila	0	1	0	0	0	0	0
Cortinarius suaveolens Bataille & Joachim	1	1	0	0	0	0	0
Cortinarius subferrugineus (Batsch) Fr.	1	1	1	0	1	0	0
Cortinarius suillus Fr.	1	1	0	0	0	0	0
Cortinarius sulphurinus Quél.	1	1	1	0	0	0	0
Cortinarius talus Fr.	1	1	1	1	0	0	0
Cortinarius terpsichores var. *calosporus* Melot	1	0	1	1	1	0	0
Cortinarius terpsichores var. *meridionalis* (Bidaud, Moënne-Locc. & Reumaux) A.Ortega	1	1	1	0	0	0	0
Cortinarius terpsichores var. *terpsichores* Melot	1	0	0	1	0	0	0
Cortinarius tomentosus Rob.Henry	0	1	0	0	0	0	0
Cortinarius torvus (Fr.) Fr.	1	1	1	0	1	0	1
Cortinarius trivialis J.E.Lange	1	1	1	1	1	0	1
Cortinarius turbinatorum Cor. Gut. & Vila	1	1	0	0	0	0	0
Cortinarius turgidus Fr.	1	0	0	0	0	0	0
Cortinarius umbrinoclarus Rob.Henry	0	1	1	0	0	0	0
Cortinarius umbrinolens P.D.Orton	1	1	1	0	0	0	1
Cortinarius uraceus Fr.	1	1	0	1	0	0	0
Cortinarius variiformis Malençon	1	1	1	0	1	1	0
[20]*Cortinarius varius* (Schaeff.) Fr.	1	0	1	1	0	0	0
Cortinarius veneris Bidaud, Moënne-Locc. & Reumaux	0	0	0	0	1	0	0
Cortinarius venetus (Fr.) Fr.	1	1	1	0	1	1	0

Cortinarius veraprilis Chevassut, Rob.Henry & G.Riousset	1	0	0	0	0	0	0
Cortinarius viridocaeruleus Chevassut & Rob.Henry	1	1	1	0	0	0	0
Cortinarius xanthophyllus (Cooke) Rob.Henry	1	1	1	0	0	0	0
Craterellus cornucopioides (L.) Pers.	1	1	1	1	1	0	0
Gauteria morchelliformis Vittad.	1	0	0	0	0	0	0
Gymnomyces dominguezii Mor.-Arr., J.Gómez & Calonge	1	0	0	0	0	0	0
Gynomyces ferruginascens Singer & A.H.Sm.	1	0	0	0	0	0	0
Gynomyces sublevisporus Mor.-Arr., Llistos & L.Romero	1	0	0	0	0	0	0
Gymnomyces xanthosporus (Hawker) A.H.Smith	1	0	0	0	0	0	0
Gyroporus castaneus (Bull.) Quél.	1	1	1	0	0	0	1
Hebeloma album Peck	1	0	1	0	0	0	0
Hebeloma anthracophilum Maire	0	0	1	0	0	0	0
Hebeloma crustuliniforme (Bull.) Quél.	1	1	1	1	1	0	1
[21]*Hebeloma eburneum* Malençon	1	0	0	0	0	0	0
Hebeloma edurum Métrod ex Bon	1	0	1	1	1	0	1
Hebeloma hiemale Bres.	1	1	0	1	1	0	0
Hebeloma leucosarx P.D.Orton	1	0	1	1	1	0	0
Hebeloma mesophaeum (Pers.) Quél.	1	0	1	0	1	0	0
Hebeloma radicosum (Bull.) Ricken	0	0	1	0	0	0	0
Hebeloma sacchariolens var. *pallidoluctuosum* (Gröger & Zschiesch.) Quadr.	1	1	1	0	0	0	0
Hebeloma sarcophyllum (Peck) Sacc.	1	0	1	0	1	0	1
Hebeloma sinapizans (Fr.) Sacc.	1	1	1	1	1	0	0
Hebeloma sordescens Vesterh.	1	0	0	0	0	0	0
Hebeloma sordidum Maire	1	0	1	1	1	0	1
Hydnellum concrescens (Pers.) Banker	1	1	1	0	1	0	0
Hydnellum ferrugineum (Fr.) P.Karst.	1	0	1	1	0	0	0
Hydnellum scrobiculatum (Fr.) P.Karst.	1	0	1	0	0	0	1
Hydnum albidum Peck	1	1	0	0	0	0	0
Hydnum repandum L.	1	1	1	1	0	0	0
Hydnum rufescens Pers.	1	1	1	1	1	1	1
Hygrophorus arbustivus Fr.	1	1	1	0	0	0	0
Hygrophorus chrysodon (Batsch) Fr.	1	0	1	1	0	0	0
[22]*Hygrophorus cossus* (Sowerby) Fr.	1	1	1	1	1	0	1
Hygrophorus discoxanthus Rea	1	1	1	0	0	0	0
Hygrophorus eburneus (Bull.) Fr.	1	1	1	1	0	0	0
Hygrophorus leucophaeo-ilicis Bon & Chevassut	1	1	1	0	1	0	0
Hygrophorus lindtneri M.M.Moser	0	1	0	0	0	0	0
Hygrophorus melizeus Fr.	1	0	0	0	0	0	0
Hygrophorus penarius Fr.	1	1	1	0	0	0	1
Hygrophorus persoonii Arnolds	1	1	1	1	1	0	1
Hygrophorus persoonii var. *fuscovinosus* (Bon) Bon	1	1	0	0	0	0	0
Hygrophorus pseudodiscoideus (Maire) Malençon & Bertault	1	0	1	0	0	0	0
Hygrophorus roseodiscoideus Bon & Chevassut	1	1	0	0	1	0	0
Hygrophorus russula (Schaeff.) Kauffman	1	1	1	0	0	0	0
Hymenogaster arenarius Tul. & C.Tul.	1	0	0	0	0	0	0
Hymenogaster bulliardi Vittad.	1	0	0	0	0	0	0
Hymenogaster citrinus Vittad.	1	0	0	0	0	0	0
Hymenogaster decorus Tul. & C.Tul.	1	0	0	0	0	0	0
Hymenogaster griseus Vittad.	1	0	0	0	0	0	0
Hymenogaster luteus Vittad.	1	1	0	0	0	0	0

	Qball	Qil	Qsub	Qpyr	Qfag	Qcoc	Qcan
Hymenogaster lycoperdineus Vittad.	1	0	0	0	0	0	0
[23]*Hymenogaster niveus* Vittad.	1	0	0	0	0	0	0
Hymenogaster olivaceus Vittad.	1	0	0	0	0	0	0
Hymenogaster populetorum Tul.	1	0	0	0	1	0	0
Hymenogaster thwaitesii Berk & Broome	1	0	0	0	0	0	0
Hymenogaster vulgaris Tul. apud Berk. & Br.	1	0	0	0	0	0	0
Hysterangium cistophilum Tul. & C.Tul.	1	0	1	0	0	0	0
Hysterangium clathroides Vittad.	1	0	1	0	0	0	0
Hysterangium rickenii Soehner	1	0	0	0	1	0	0
Hysterangium stoloniferum Tul. & C.Tul.	1	0	0	0	0	1	0
Inocybe abjecta P.Karst.	1	0	0	1	0	0	0
Inocybe adaequata (Britzelm.) Sacc.	1	1	1	0	0	1	1
Inocybe albomarginata Velen.	0	0	1	0	0	0	0
Inocybe amethystina Kuyper	0	0	1	0	0	0	0
Inocybe asterospora Quél.	1	1	1	1	0	0	0
Inocybe bongardii (Weinm.) Quél.	1	0	1	1	1	0	0
Inocybe bongardii var. *pisciodora* (Donadini & Riousset) Kuyper	0	1	0	0	0	0	0
Inocybe bresadolae Massee	0	0	1	0	0	0	0
Inocybe brevicystis Métrod ex Kuyper	0	0	0	0	1	0	0
Inocybe brunneorufa Stangl & J.Veselsky	1	0	0	0	0	0	0
Inocybe cervicolor (Pers.) Quél.	1	1	1	1	1	0	0
Inocybe cincinnata (Fr.) Quél.	1	1	1	0	0	0	0
Inocybe cincinnata var. *major* (S.Petersen) Kuyper	1	1	1	0	0	0	0
Inocybe cookei Bres.	1	1	1	0	0	0	0
Inocybe corydalina Quél.	1	0	1	0	0	0	0
Inocybe curvipes P.Karst.	1	0	1	1	0	0	0
Inocybe dulcamara (Alb. & Schwein.) P.Kumm.	1	0	1	1	1	0	0
Inocybe erubescens A.Blytt	1	0	0	0	0	0	0
Inocybe flavella P.Karst.	0	1	1	1	1	0	0
Inocybe flocculosa (Berk.) Sacc.	1	1	1	0	1	0	1
Inocybe fraudans (Britzelm) Sacc.	1	1	1	0	0	0	1
Inocybe furfurea Kühner	0	1	0	0	0	0	0
Inocybe fuscidula Velen.	1	1	1	0	0	0	0
Inocybe geophylla/(Pers.) P.Kumm.	1	1	1	0	0	0	1
Inocybe geophylla var. *lilacina* Gillet	1	1	1	1	1	0	0
Inocybe glabrodisca P.D.Orton	0	0	1	0	0	0	0
Inocybe glabrescens Velen.	0	0	0	0	1	0	0
Inocybe glabripes Ricken	0	1	0	0	0	0	0
Inocybe godeyi Gillet	1	1	1	0	1	0	0
Inocybe griseolilacina J.E.Lange	1	1	1	1	1	0	0
Inocybe haemacta (Berk. & Cooke) Sacc.	0	0	1	0	0	0	0
Inocybe heimii Bon	0	1	0	0	0	1	0
Inocybe hirtella Bres.	1	0	0	0	0	0	0
Inocybe jacobii Kühner	0	0	0	1	0	0	0
Inocybe lacera (Fr.) P.Kumm.	0	1	0	1	0	0	0
Inocybe lanuginosa var. *ovatocystis* (Boursier & Kühner) Stangl	0	0	1	0	0	0	0
Inocybe maculata Boud.	1	1	1	1	0	0	1
Inocybe malençonii R.Heim	1	1	0	0	0	0	0
Inocybe margaritispora (Berk.) Sacc.	0	0	1	1	0	0	0
Inocybe mixtilis (Britzelm.) Sacc.	1	1	0	1	1	0	0
Inocybe muricellata Bres.	1	0	1	0	0	0	0
Inocybe nitidiuscula (Britzelm.) Lapl.	1	0	0	0	0	0	0

Inocybe oblectabilis (Britzelm.) Sacc.	1	0	1	0	0	0	0
Inocybe obscurobadia (J.Favre) Grund & Stuntz	1	1	1	0	0	0	0
Inocybe obscuroides P.D.Orton	0	1	0	0	0	0	0
Inocybe olida Maire	0	1	1	0	0	0	0
Inocybe pelargonium Kühner	1	0	1	0	1	0	0
Inocybe posterula (Britzelm.) Sacc.	1	0	1	0	0	0	0
Inocybe praetervisa Quél.	1	0	1	0	0	0	0
Inocybe pseudoestricta Stangl & J.Veselsky	1	0	0	1	0	0	0
Inocybe pudica Kühner	1	0	1	1	0	0	0
Inocybe pusio P.Karst.	1	1	1	0	1	0	0
Inocybe quietiodor Bon	1	0	1	0	0	0	0
Inocybe rimosa (Bull.) P.Kumm.	1	1	1	1	1	0	1
Inocybe similis Bres.	0	1	0	0	1	0	0
Inocybe sindonia (Fr.) P.Karst.	1	1	1	1	1	0	0
Inocybe splendens R.Heim	1	1	0	0	0	0	0
Inocybe splendens var. *phaeoleuca* (Kühner) Kuyper	1	0	1	0	0	0	0
Inocybe subporospora Kuyper	1	0	0	0	0	0	0
Inocybe subtrivialis Esteve-Rav., Villarreal & Heykoop	1	0	0	0	0	0	0
Inocybe tarda Kühner	1	1	0	0	0	0	0
Inocybe tenebrosa Quél.	1	1	1	1	0	0	0
Inocybe tenuicystidiata E.Horak & Stangl	0	0	1	0	0	0	0
Inocybe terrigena (Fr.) Kühner	1	0	0	0	0	0	0
Inocybe tjallingiorum Kuyper	0	0	0	0	1	0	0
Inocybe xanthomelas Boursier & Kühner	1	0	1	0	1	0	0
[24]*Laccaria affinis* (Singer) Bon	0	0	0	1	0	0	0
Laccaria amethystina Cooke	1	1	1	1	1	0	1
Laccaria bicolor (Maire) P.D.Orton	1	0	1	1	1	0	0
Laccaria fraterna (Cooke & Massee) Pegler	1	0	1	0	0	0	0
Laccaria laccata var. *laccata* (Scop.) Cooke	1	1	1	1	1	1	0
[25]*Laccaria laccata* var. *pallidifolia* (Peck) Peck	1	0	1	1	1	0	1
Laccaria laccata var. *pseudobicolor* Bon	1	0	1	0	0	0	0
Laccaria proxima (Boud.) Pat.	1	0	1	1	1	0	0
Lactarius acerrimus Britzelm.	1	1	1	1	1	0	0
Lactarius acris (Bolton) Gray	0	1	0	0	0	0	0
Lactarius atlanticus Bon	1	1	1	0	1	0	0
Lactarius azonites (Bull.) Fr.	1	1	1	1	1	0	0
Lactarius blennius (Fr.) Fr.	0	1	0	0	0	0	0
Lactarius camphoratus (Bull.) Fr.	1	1	1	1	1	0	0
Lactarius chrysorrheus Fr.	1	1	1	1	1	0	1
Lactarius circellatus Fr.	0	0	1	0	0	0	0
[26]*Lactarius decipiens* Quél.	1	1	1	1	0	1	1
Lactarius evosmus Kühner & Romagn.	1	0	1	0	1	0	0
Lactarius fuliginosus (Fr.) Fr.	1	1	1	0	0	0	1
Latarius ilicis Sarnari	0	1	1	0	1	1	0
Lactarius lacunarum Romagn. ex Hora	0	0	0	1	1	0	0
Lactarius luridus (Pers.) Gray	0	0	1	1	0	0	1
Lactarius luteolus Peck	0	0	1	0	0	0	0
Lactarius mairei Malençon	1	1	1	0	1	1	0
Lactarius mediterranensis Llistos & Bellu	1	0	0	0	1	1	0
[27]*Lactarius mitissimus* Fr.	0	0	0	1	0	0	0
Lactarius pallidus Pers.	1	1	0	0	0	0	0
Lactarius pergameus (Sw) Fr.	0	0	1	0	0	0	0
Lactarius piperatus (L.) Pers.	0	0	1	0	0	0	1
Lactarius pterosporus Romagn.	0	1	0	0	0	0	0
Lactarius pyrogalus (Bull.) Fr.	0	1	1	0	0	0	0

	Qball	Qil	Qsub	Qpyr	Qfag	Qcoc	Qcan
Lactarius pseudoscrobiculatus Basso, Neville & Poumarat	0	0	0	0	1	0	0
Lactarius quietus (Fr.) Fr.	1	0	1	1	1	0	1
Lactarius romagnesii Bon	1	0	0	0	0	0	0
Lactarius rufus (Scop.) Fr.	0	0	0	1	0	0	0
Lactarius rugatus Kühner & Romagn.	1	1	1	1	1	0	1
Lactarius serifluus (DC.) Fr.	1	1	1	0	1	0	0
Lactarius subdulcis (Pers.) Gray	1	1	1	1	1	0	0
Lactarius subumbonatus Lindgr.	1	1	1	1	0	0	1
Lactarius tesquorum Malençon	1	0	1	0	0	0	0
Lactarius uvidus (Fr.) Fr.	0	1	1	0	0	0	0
Lactarius vellereus (Fr.) Fr.	1	0	1	1	1	0	0
Lactarius violascens (J.Otto) Fr.	1	1	1	0	0	0	0
Lactarius zonarius (Bull.) Fr.	1	1	1	1	1	0	1
Lactarius zugazae G.Moreno, Montoya, Bandala & Heykoop	1	0	1	0	0	0	0
Leccinum crocipodium (Letell.) Watling	1	1	1	1	1	0	0
Leccinum lepidum (H.Bouchet ex Essette) Bon & Contu	1	1	1	0	1	0	1
Leccinum quercinum (Pilát) E.E.Green & Watling	0	0	0	1	0	0	0
Leucocortinarius bulbiger (Alb. & Schwein.) Singer	0	0	0	1	0	0	0
Melanogaster ambiguus (Vittad.) Tul. & C.Tul.	1	0	0	0	0	0	0
Melanogaster broomeianus Berk.	1	0	0	0	0	0	0
Melanogaster macrosporus Zeller	1	0	0	0	0	0	0
Melanogaster tuberiformis Corda	1	0	0	0	0	0	0
Melanogaster variegatus (Vittad.) Tul. & C.Tul.	1	0	1	0	0	0	0
Paxillus involutus (Batsch) Fr.	1	1	1	0	0	0	0
Phellodon niger (Fr.) P.Karst.	0	1	0	0	0	0	0
Pisolithus arhizus (Scop.) Rauschert	1	0	1	1	0	1	0
[28]*Pseudocraterellus undulatus* (Pers.) Rauschert	0	1	0	0	0	0	0
Ramaria aurea (Schaeff.) Quél.	0	1	1	0	1	0	0
Ramaria botrytis (Pers.) Ricken	0	1	1	0	0	0	1
Ramaria broomei (Cotton & Wakef.) R.H.Petersen	0	0	0	0	1	0	0
Ramaria decurrens (Pers.) R.H.Petersen	0	1	0	0	0	0	0
Ramaria fennica (P.Karst.) Ricken	0	0	1	0	0	0	0
Ramaria fennica var. *olivacea* Schild	0	0	1	0	0	0	1
Ramaria flava (Schaeff.) Quél.	1	1	1	1	1	0	1
Ramaria flavescens (Schaeff.) R.H.Petersen	0	0	1	0	0	0	1
Ramaria flavigelatinosa Marr & D. E.Stuntz	0	0	1	0	0	0	1
Ramaria flavobrunnescens (G.F./A+K.) Corner	0	0	1	0	0	0	0
Ramaria flavosalmonicolor Schild	0	0	0	0	0	0	1
Ramaria formosa (Pers.) Quél.	1	1	1	1	1	0	1
Ramaria gracilis (Pers.) Quél.	0	1	1	0	0	0	0
Ramaria mediterranea Schild & Franchi	0	0	1	1	0	0	0
Ramaria pallida (Schaeff.) Ricken	0	0	1	0	0	0	0
Ramaria quercus-ilicis Schild	1	0	0	0	0	0	0
Ramaria rubripermanens Marr & D.E.Stuntz	0	0	1	0	0	0	1
Ramaria stricta (Pers.) Quél.	1	0	1	0	1	0	1
Ramaria subtilis (Coker) Schild	1	0	0	0	1	0	0
Russula acetolens Rauschert	0	0	1	1	0	0	0
Russula acrifolia Romagn.	1	1	1	1	1	0	0
Russula adusta (Pers.) Fr.	0	0	1	0	0	0	0
Russula aeruginea Fr.	1	0	1	0	0	0	0

Russula albonigra (Krombh.) Fr.	1	1	1	0	0	0	0
Russula albonigra fo. *pseudonigricans* (Romagn.) Bon	1	0	1	0	0	0	0
Russula alutacea (Fr.) Fr.	1	1	1	0	1	0	0
Russula amoena Quél.	0	0	1	1	0	0	0
Russula amoenicolor fo. *nigrosanguinea* Romagn.	0	0	1	0	0	0	0
Russula amoenicolor fo. *olivacea* Maire	0	0	1	0	0	0	0
Russula amoenicolor Romagn.	1	1	1	0	0	0	0
Russula amoenolens Romagn.	1	0	1	0	0	0	0
Russula anatina Romagn.	0	1	0	0	0	1	0
Russula anthracina Romagn.	1	0	1	0	0	0	0
Russula monspeliensis Sarnari	1	0	1	0	0	0	1
Russula aurea Pers.	1	1	1	1	0	0	1
Russula aurora (Krombh.) Bres.	0	0	1	0	0	0	0
Russula clariana R.Heim ex Kuyper & V.Uure	0	0	0	1	0	0	0
Russula chloroides (Krombh.) Bres.	1	1	1	1	0	0	1
Russula cicatricata Romagn. ex Bon	0	0	1	0	0	0	0
Russula cyanoxantha (Schaeff.) Fr.	1	1	1	1	0	0	1
[29]*Russula cyanoxantha* var. *cutrefacta* (Cooke) Sarnari	1	0	1	0	0	0	0
[30]*Russula cyanoxantha* var. *peltereaui* Singer	1	0	1	0	1	0	1
Russula decipiens (Singer) Kühner & Romagn.	1	1	1	1	0	0	0
Russula delica Fr.	1	1	1	1	1	0	0
Russula densifolia Secr. ex Gillet	0	1	1	0	0	0	0
Russula fellea (Fr.) Fr.	0	0	1	0	0	0	0
Russula foetens (Pers.) Pers.	1	1	1	1	1	0	1
Russula fragilis Fr.	1	1	1	0	1	0	1
Russula fragrantissima Romagn.	0	0	1	0	0	0	1
Russula galochroa (Fr.) Fr.	1	0	1	0	0	0	0
Russula globispora (J. Blum) Bon	1	0	0	0	0	1	0
Russula graveolens fo. *purpurata* (Crawshay) P.-I.Keizer & Arnolds	0	0	1	0	0	0	1
Russula graveolens Romell	1	0	1	1	0	0	0
[31]*Russula graveolens* var. *megacantha* Bon	1	0	1	0	0	0	0
Russula grisea (Batsch) Fr.	1	0	1	0	0	0	0
Russula heterophylla (Fr.) Fr.	1	0	1	1	0	0	0
Russula ilicis Romagn., Chevassut & Privat	1	1	0	0	0	1	0
Russula illota Romagn.	0	0	1	0	0	0	0
Russula integra (L.) Fr. *sensu* Maire	0	1	0	0	0	0	0
Russula insignis Quél.	1	0	1	0	0	0	0
[32]*Russula krombholzii* Schaeff.	0	0	1	1	1	0	0
[33]*Russula laurocerasi* Melzer	0	1	1	1	0	0	0
[34]*Russula lepida* Fr.	0	1	1	1	0	0	1
Russula lilacea Quél.	1	1	1	1	0	0	0
[35]*Russula lundellii* Singer	0	0	1	0	0	0	0
Russula lutea (Huds.) Gray	0	0	0	1	0	0	0
Russula luteotacta Rea	1	1	1	0	0	0	0
Russula maculata Quél. & Roze	1	1	1	0	1	0	0
Russula maculata var. *bresadolana* (Singer) Romagn.	0	0	1	0	0	0	1
[36]*Russula mairei* Singer	0	1	1	1	0	0	0
Russula melliolens Quél.	1	1	1	0	0	0	0
Russula melzeri Zvára	0	0	0	1	0	0	0
Russula minutula Velen.	0	1	0	0	0	0	0
Russula multicolor J.Blum	0	0	0	1	0	0	0
Russula nigricans (Bull.) Fr.	1	0	1	1	0	0	1
Russula ochroleuca (Pers.) Fr.	0	0	1	0	0	0	0

	Qball	Qil	Qsub	Qpyr	Qfag	Qcoc	Qcan
Russula odorata Romagn.	1	0	1	0	0	0	0
Russula olivacea (Schaeff.) Pers.	1	1	1	0	0	0	0
Russula olivacea var. *pavonina* (Bres.) Reumaux	1	0	1	0	0	0	0
Russula pallidospora J.Blum ex Romagn.	0	1	0	0	0	0	0
Russula parazurea Jul.Schäff.	1	0	1	0	0	0	1
Russula pectinata (Bull.) Fr.	1	0	0	0	0	0	0
Russula pectinatoides Peck	1	1	1	1	0	0	0
Russula persicina Krombh.	1	1	1	0	0	0	0
Russula pseudoaeruginea (Romagn.) Kuyper & Van Vuure	1	0	0	0	0	0	0
Russula pseudointegra Arnoult & Goris	1	0	1	0	0	0	0
Russula puellaris Fr.	1	1	1	0	0	0	0
Russula raoultii Quél.	0	0	1	0	0	0	0
Russula risigallina (Batsch) Sacc.	1	1	1	1	0	0	1
Russula risigallina fo. *luteorosella* (Brizelm.) Bon	0	0	0	1	0	0	0
Russula romellii Maire	0	1	0	0	0	0	0
Russula rosea Pers.	0	1	0	0	0	0	0
Russula roseipes Secr. ex Bres.	0	0	0	1	0	0	0
Russula rubroalba (Singer) Romagn.	1	1	1	1	0	0	1
Russula rubroalba var. *albocretacea* Sarnari	1	0	1	0	0	0	0
Russula seperina Dupain	1	1	0	0	0	0	0
Russula silvestris (Singer) Reumaux	1	0	1	0	1	0	0
Russula sororia Fr.	1	1	1	0	0	0	1
[37]*Russula sororia* var. *pseudoaffinis* (Migl. & Nicolaj) Sarnari	0	0	1	0	0	0	0
Russula straminea Malençon	1	0	1	0	0	0	0
Russula subazurea Bon	1	0	1	0	0	0	1
Russula subfoetens Wm.G.Sm.	1	0	1	1	1	0	0
Russula vesca Fr.	1	1	1	0	1	0	0
Russula vinosobrunnea (Bres.) Romagn.	1	1	1	0	1	0	0
Russula vinosopurpurea Jul.Schäff.	0	0	0	1	0	0	0
Russula violeipes Quél.	1	1	1	0	0	0	1
Russula werneri Maire	0	0	0	1	0	0	0
Russula virescens (Schaeff.) Fr.	1	0	1	0	0	1	0
Sarcodon fennicus (P.Karst.) P.Karst.	0	0	1	0	0	0	0
Sarcodon cyrneus Maas Geest.	1	0	1	1	0	0	0
Sarcodon imbricatus (L.) P.Karst.	0	0	1	1	0	0	0
Sarcodon joeides (Pass.) Bat.	0	1	0	0	0	0	0
Sarcodon leucopus (Pers.) Maas Geest. & Nannf.	1	1	1	0	0	0	0
Sarcodon scabrosus (Fr.) P.Karsten	1	0	1	0	1	0	0
Scleroderma areolatum Ehrenb.	0	1	0	0	0	0	0
Scleroderma cepa Pers.	1	0	1	0	0	0	0
Scleroderma citrinum Pers.	1	0	0	1	0	0	0
Scleroderma meridionale Demoulin & Malençon	1	0	1	0	0	0	1
Scleroderma polyrhizun (J.F.Gmel.) Pers.	1	1	1	1	0	0	1
Scleroderma verrucosum Bull.	1	1	1	1	1	0	1
Thelephora anthocephala (Bull.) Fr.	0	0	0	0	1	0	0
Thelephora caryophyllea (Schaeff.) Pers.	1	0	1	0	1	0	0
Thelephora palmata (Scop.) Fr.	1	0	0	0	0	0	0
Thelephora terrestris Ehrenb.	1	0	1	0	0	0	0
Tricholoma acerbum (Bull.) Vent.	1	1	1	1	1	0	0
Tricholoma albidum Bon	0	0	1	0	0	0	0

Tricholoma album (Schaeff.) P.Kumm.	1	1	1	1	1	0	1
Tricholoma album var. *thalliophilum* Bon	0	1	0	0	0	0	0
Tricholoma argyraceum (Bull.) Gillet	1	1	1	0	0	0	0
Tricholoma atrosquamosum (Chevall.) Sacc.	1	1	1	0	1	0	1
[38]*Tricholoma atrosquamosum* var. *squamulosum* (Bres.) Mort. Chr. & Noordel.	1	1	1	0	1	0	0
Tricholoma aurantium (Schaeff.) Ricken	1	1	0	0	0	0	0
Tricholoma bresadolanum Clemençon	0	1	1	0	0	0	0
Tricholoma bufonium (Pers.) Gillet	1	0	1	1	0	0	0
Tricholoma caligatum (Viv.) Ricken	1	0	1	0	1	0	0
Tricholoma cingulatum (Ahnfelt) Jacobasch	0	0	1	0	0	0	0
Tricholoma columbetta (Fr.) P.Kumm.	0	1	1	1	0	0	1
Tricholoma coryphaeum (Fr.) Gillet	0	0	1	0	0	0	1
Tricholoma lascivum (Fr.) Gillet	1	0	1	0	1	0	0
Tricholoma myomyces (Pers.) J.E.Lange	1	1	1	0	1	0	0
Tricholoma orirubens var. *basirubens* Bon	1	0	0	1	1	0	0
Tricholoma orirubens var. *orirubens* Quel.	1	1	0	0	0	0	0
Tricholoma pardalotum Herink & Kotl.	1	0	0	0	0	0	0
Tricholoma portentosum (Fr.) Quél.	1	0	1	0	1	0	0
Tricholoma psammopus (Kalchbr.) Quél.	1	0	1	0	0	0	0
Tricholoma ramentaceum var. *quercus-ilicis* Bon, Narducci & Petrucci	0	0	1	0	0	0	0
Tricholoma saponaceum (Fr.) P.Kumm.	1	1	1	1	1	0	1
[39]*Tricholoma saponaceum* var. *boudieri* (Barla) Barla	0	0	1	0	0	0	0
Tricholoma saponaceum var. *squamosum* (Cooke) Rea	0	0	1	0	0	0	0
Tricholoma scalpturatum (Fr.) Quél.	1	1	1	1	1	0	1
Tricholoma scioides (Pers.) C.Martin	0	0	1	0	0	0	0
Tricholoma sejunctum (Sowerby) Quél.	1	1	1	0	1	0	1
Tricholoma stiparophyllum Fr. & N.Lund	1	0	1	0	0	0	0
Tricholoma sulphurescens Bres.	1	1	0	0	0	0	0
Tricholoma sulphureum (Bull.) P.Kumm.	1	1	1	1	1	0	1
Tricholoma triste (Scop.) Quél.	1	0	0	0	1	0	0
Tricholoma ustale (Fr.) P.Kumm.	1	1	1	1	1	0	1
Tricholoma ustale var. *rufoaurantiacum* Bon	0	0	1	0	0	0	0
Tricholoma ustaloides Romagn.	1	1	1	1	1	0	1
Tricholoma viridilutescens M.M.Moser	0	0	1	0	0	0	0
Wakefieldia macrospora (Hawker) Hawker	1	1	0	0	0	0	0
Xerocomus armeniacus (Quél.) Quél.	1	0	1	0	1	0	0
Xerocomus badius (Fr.) Kühner	0	0	1	1	0	0	1
Xerocomus chrysenteron (Bull.) Quél.	1	1	1	0	1	0	1
[40]*Xerocomus communis* (Bull.) Bon	1	0	0	0	1	0	0
Xerocomus dryophilus (Thiers) Singer	0	0	0	0	1	0	0
Xerocomus ichnusanus Alessio, Galli & Littini	1	0	0	0	1	0	0
Xerocomus moravicus (Vacek) Herink	0	1	1	0	1	0	1
Xerocomus persicolor H.Engel, Klofac, H.Grünert & R.Grünert	1	0	1	0	1	0	0
Xerocomus porosporus Imler	1	0	1	0	0	0	0
[41]*Xerocomus roseoalbidus* Alessio & Littini	0	0	1	1	0	0	0
Xerocomus rubellus (Krombh.) Quél.	1	1	1	0	0	0	1
[42]*Xerocomus spadiceus* (Fr.) Quél.	1	1	0	0	0	0	0
Xerocomus subtomentosus (L.) Quél.	1	1	1	1	1	0	0
[43]Xerocomus subtomentosus var. *ferrugineus*	1	1	1	1	1	0	1

	Qball	Qil	Qsub	Qpyr	Qfag	Qcoc	Qcan
(Schaeff.) Krieglst.							
[44]*Xerocomus subtomentosus* var. *lanatus* (Rostk.) Smotl.	1	0	1	0	0	0	1
[45]*Xerocomus subtomentous* var. *legue*i (Boud.) Maire	0	0	1	0	0	0	1
Xerocomus tumidus (Fr.) E.-J.Gilbert	1	0	1	0	0	0	0
Zelleromyces meridionalis Calonge, Mor.-Arr. & J.Gómez	1	0	0	0	0	0	0
	416	288	411	171	174	21	107

Remarks on the current nomenclatural status of macrofungus taxa compiled for *Quercus* spp. forests. [1]Include *Amanita valens* (E.-J.Gilbert) Bertault. [2]Corresponds to *Amanita ceciliae* (Berk. & Broome) Bas. [3]Corresponds to *Amanita battarrae* (Boud.) Bon. [4]Corresponds to *Amanita curtipes* (E.-J.Gilbert). [5]Corresponds to *Boletus reticulatus* Schaeff. [6]Corresponds to *Boletus queletii* Schulzer. [7]Corresponds to *Cantharellus cibarius* var. *ferruginascens* (P.D.Orton) Courtec. [8]Corresponds to *Cortinarius majusculus* Kühner. [9]Corresponds to *Cortinarius amaoenolens* Rob.Henry & P.D.Orton. [10]Doubtful species (strongly linked to montane coniferous forests). [11]Corresponds to *Cortinarius nanceiensis* var. *bulbipodius* Chevassut & Rob.Henry. [12]Include *Cortinarius coerulescentium* Rob.Henry. [13]Match to the *sensu* of Malençon & Bertault (1970). [14]Corresponds to *Cortinarius boudieri* Rob.Henry. [15]Corresponds to *Cortinarius aleuriosmus* Maire. [16]Corresponds to *Cortinarius subturibulosus* Kizlik & Trecol. [17]Corresponds to *Cortinarius rigens* (Pers.) Fr. [18]Corresponds to *Cortinarius eufulmineus* Rob.Henry. [19]Corresponds to *Cortinarius rubellus* Cooke. [20]Possibly Corresponds to *Cortinarius variiformis* Malençon. [21]Doubtful species (it is thought to grow only over *Cedrus*). [22]Corresponds to *Hygrophorus eburneus* var. *cossus* (Sowerby) Quél. [23]Corresponds to *Protoglossum niveum* (Vittad.) T.M.May. [24]Corresponds to *Laccaria laccata* (Scop.) Cooke. [25]Corresponds to *Laccaria laccata* (Scop.) Cooke. [26]Corresponds to *Lactarius lacunarum* Romagn. ex Hora. [27]Corresponds to *Lactarius aurantiacus* (Pers.) Gray. [28]Corresponds to *Pseudocraterellus sinuosus* (Fr.) Corner. [29]Corresponds to *Russula cyanoxantha* (Schaeff.) Fr. [30]Corresponds to *Russula cyanoxantha* (Schaeff.) Fr. [31]Corresponds to *Russula graveolens* Romell. [32]Corresponds to *Russula atropurpurea* (Krombhol.) Britzelm. [33]Corresponds to *Russula grata* Britzelm. [34]Corresponds to *Russula rosea* Pers. [35]Corresponds to *Russula intermedia* P.Karst. [36]Corresponds to *Russula nobilis* Velen. [37]Corresponds to *Russula pseudoaffinis* Migl. & Nicolaj. [38]Corresponds to *Tricholoma squarrulosum* Bres. [39]Corresponds to *Tricholoma saponaceum* var. *lavedanum* Rolland. [40]Corresponds to *Xerocomus chrysenteron* (Bull.) Quél. [41]Corresponds to *Rubinoboletus roseoalbidus* (Alessio & Littini) De Kesel. [42]Corresponds to *Xerocomus ferrugineus* Fr. [43]Corresponds to *Xerocomus ferrugineus* Fr. [44]Corresponds to *Xerocomus subtomentosus* L. [45]Corresponds to *Xerocomus subtomentosus* L.

NOTE: Despite that the majority of the *Xerocomus* species have been included in the genus *Boletus* (www.speciesfungorum.com), recent phylogenetic studies (Bindez & Hibbett 2006), demonstrate that they constitute an independent genus.

Appendix 2. Approximated number of total taxa currently described for the genera here compiled. (Source: Kirk et al. 2001, Mycobank; www.mycobank.org) (order of the genera in brackets).

Albatrellus (Polyporales)	12 taxa
Amanita (Agaricales)	500
Aureoboletus (Boletales)	5
Boletopsis (Thelephorales)	5
Boletus (Boletales)	300
Cantharellus (Cantharellales)	65
Chalciporus (Boletales)	15
Clavariadelphus (Phallales)	18

Cortinarius (Agaricales)	2000
Craterellus (Cantharellales)	20
Gauteria (Phallales)	25
Gymnomyces (Russulales)	15
Gyroporus (Boletales)	10
Hebeloma (Agaricales)	150
Hydnellum (Thelephorales)	38
Hydnum (Cantharellales)	120
Hygrophorus (Agaricales)	100
Hymenogaster (Boletales)	100
Hysterangium (Phallales)	50
Inocybe (Agaricales)	500
Laccaria (Agaricales)	25
Lactarius (Russulales)	400
Leccinum (Boletales)	75
Leucortinarius (Agaricales)	1
Melanogaster (Boletales)	25
Paxillus (Boletales)	15
Phellodon (Thelephorales)	16
Pisolithus (Boletales)	5
Protoglossum (Boletales)	8
Pseudocraterellus (Cantharellales)	22
Ramaria (Phallales)	220
Rubinoboletus (Boletales)	11
Russula (Russulales)	750
Sarcodon (Thelephorales)	36
Scleroderma (Boletales)	25
Thelephora (Thelephorales)	49
Tricholoma (Agaricales)	200
Wakefieldia (Boletales)	2
Xerocomus (Boletales)	170
Zelleromyces (Russulales)	17