MACROFUNGI IN THE HISTORICAL "HANBURY" BOTANICAL GARDENS (LIGURIA, NW ITALY): A PRELIMINARY CHECK-LIST

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ABSTRACT

This paper presents the results of the study on the mycoflora of a botanical garden located in Liguria (NW Italy). Mycological investigations were performed to list the presence of both epigeous and hypogeous macrofungal species in the historical Hanbury Botanical Gardens. The results show that several interesting and uncommon species, especially among hypogeous fungi, occur in the site. Ectomycorrhizal species and soil saprotrophs were more numerous than woody decaying and parasite fungi. This site, declared a Regional Protected Area and a Site of Community Importance for its high plant biodiversity, also constitutes an interesting area from a mycological perspective. Due to the importance of fungi in terrestrial ecosystems functioning and their potential interactions with plants, further studies should be planned in order to increase knowledge on the fungal components that can are present in botanical gardens.

KEY WORDS
Fungi; check-list; historic gardens; conservation.

INTRODUCTION

Botanical gardens are known for being *"an institution holding documented collections of living plants for the purposes of scientific research, conservation, display and education"* (BGCI, 1987). Hosting a large collection of plants, derived from different geographical areas around the world, botanical gardens are recognized as having a key role in global plant conservation (Hulme, 2011).

It has been estimated that within the current 2.500 existing botanical gardens there are almost 10.000 living plants, many of which are threatened or are already extinct in the world (see www.bgci.org; Oldfield, 2010). International agreements that deal with biodiversity conservation, such as the Convention on Biological Diversity (CBD, 1992) and the Global Strategy for Plant Conservation (GSPC, 2002), remark on the importance of botanical gardens for *ex situ* conservation actions in the gardens.

Focusing on the biodiversity of botanical gardens, very little or no information is available on other organisms, beyond plants, that might be present.

Plants for instance, engage in intimate relationships with fungi forming a symbiotic association in which both partners are likely to benefit. One of the most important symbiosis type is called "mycorrhizae" where fungi live on ("ectomycorrhizae") and in ("endomycorrhizae") the plant roots. In this case both the plant and the fungus depend on this relationship to develop and survive (Mueller, 2004; Deacon, 2006). It is estimated that as many as 90% of all plants depend on mycorrhizae to survive and this symbiosis type probably enabled plants to colonize land around 450 million years ago (Amaranthus, 1999; Tedersoo et al., 2010).

A large number of fungi are adapted to grow as parasites on plants, obtaining some or all of the nutrients from the living tissues of their host. Parasitic fungi affect both wild and cultivated plants, sometimes causing extensive damage that can be very costly for the agricultural and horticultural industries. Some of these fungi include rusts, smuts and moulds, but can also include macrofungi (Kirk at al., 2008) like the forestry pests belonging to *Armillaria* (Fr.) Staude genus (Deacon, 2006).

The importance of fungi for a plants survival and benefits that fungi bring, make essential to know more about the mycobiota (Kirk et al., 2008) of an habitat. Fungi play a crucial role in terrestrial ecosystems (e.g. nutrients cycles, nutrients transport, decomposition) and they establish important symbiotic (mutualistic or pathogenic) interactions with plants.

Actually, to the best of our knowledge, no information is available on the macrofungal component associated with botanical gardens. This lack of knowledge encouraged us to carry out mycological surveys in a historical botanical garden located in Liguria (North-west Italy), with the aim of listing the macrofungal species. In the past, this Ligurian site has been studied once before by Professor O. Penzig (Penzig, 1884) on the presence of fungal species.

MATERIALS AND METHODS

Study area

The historical “Hanbury” Botanical Gardens (GBH; Fig. 1) are located in Liguria (NW Italy) on the promontory of “Capo Mortola”, in the province of Imperia, a few kilometers from the boundary between Italy and France. These gardens were founded in 1867 when Sir Thomas Hanbury bought the ancient “Palazzo Orengo” and the adjacent piece of land in order to transform them into an acclimatization garden of exotic plants (Campodonico, 2010; Profumo, 2010).

The gardens cover over 19 hectares, of which about half of this surface is cultivated with plants from different areas with subtropical or warm-temperate climates; whereas, the other half is characterized by semi-natural Mediterranean vegetation, with the presence of *Pinus* *halepensis* Mill. woods and other habitats, such as the Mediterranean maquis (dominated by *Quercus ilex* L.) in the surrounding area.

Figure 1. Hanbury Botanical Gardens. Photos by http://www.giardinihanbury.com/.

GBH do not contain gardens full of borders and neat flower beds. In this site plants live "freely" and bloom, giving fruit and then produce fertile seed, thus completing the biological cycle that they have in nature.

GBH currently host a collection of approximately 3500 *taxa* including ornamental, fruit trees and medicinal herbs. In some zones, plants were gathered together on the basis of their phytogeographic or ecological or aesthetic peculiarities, such as: the Japanese garden, the Australian forest, the collection of roses, the succulent plants, the garden of perfumes, the palms, the agaves, the aloes, the acacias, the cypress avenue, the citrus orchards, the exotic fruit, the olive avenue and the giardinetti (some pictures are shown in Figures 2 and 3).

Figure 2: Hanbury Botanical Gardens pictures. Photos by http://www.giardinihanbury.com/ and by E. Zappa.

Figure 3: Hanbury Botanical Gardens pictures. Photos by http://www.giardinihanbury.com/ and by E. Zappa.

Due to the presence of a high number of flowering plants and the abundance and diversity of the plant species, in addition to the coexistence of different habitat types, the gardens and the immediate surroundings (including the sea-bed in front), were declared a Regional Protected Area in March 2000. A few years later Capo Mortola was declared a Site of Community Importance (SCI) under the Directive 92/43.

The area enjoys a Temperate Mediterranean climate with a hot, dry summer (Rivas-Martinez, 2008). January is the coldest month (average temperature 9.2°C, average minimum temperatures 6.2°C) and the minimum temperature rarely falls below zero; August is the hottest month: the average maximum temperature is 27.9°C. It rains mostly in autumn, October is the wettest month with an average of 130 mm. The average annual rainfall is about 791.3 mm (data 1979-2014).

The soil of Capo Mortola is formed by the decomposition of nummulitic limestone of the Lower Eocene period. It is heavy and clayed, in summer it becomes hard and cracks into deep fissures. In the higher part of the garden a small travertine deposit forms a sandy soil (Berger, 1912).

Data collection

Mycological investigations were performed during the period for favorable sporomata (Kirk et al., 2008) growth (April-June and September-November, 2009-2010 and 2012-2013), with a frequency of observation of once or twice time(s) per month. Quali- and quantitative sporomata analysis was focused on both epigeous and hypogeous macrofungal species. During the field surveys, notes on morphological characters and ecology of the fresh specimens (along with photographic documentation of sporomata), and chemical reactions (i.e. 10% KOH) on the surface and context of sporomata, were performed for the species identification.

Unidentified specimens were retained and later identified in laboratory. Microscopic analyses were carried out on "free hand sections", generally observed in pure water or in 3% KOH or in 0.1% ammoniacal Congo Red. When necessary, more specific reagents (i.e. Melzer reagent, Cresyl blue) were used for the identification of microscopical structures were used.

For taxonomical identification, specific European literature was consulted (e.g. Bidaud et al., 1991-1999, 1997, 200-2004, 2005- 2008, 2009-2010, 2012; Breitenbach & Kränzlin, 1995, 2000; Basso, 1999; Robich, 2003; Neville & Poumarat, 2004; Muñoz, 2005; Parra, 2008; Antonín & Noordeloos, 2010).

Systematic classification followed Hibbett et al. (2007) and Kirk et al. (2008). Nomenclature and author abbreviations were used in accordance with CABI (www.indexfungorum.org), CBS (www.cbs.knaw.nl) and IMA (www.mycobank.org).

All the identified macrofungal species were inserted into a specific database called A.L.C.E. – "*Advanced Liguria Check-list of Ectomycorrhizal and other fungi*" in order to map their presence on regional (Liguria) and national (Italy) territory.

Data analysis

The recorded *taxa* were gathered according to the higher systematic ranks: Division, Order, and Family and the identified macrofungal species were split into functional groups as done by Tedersoo et al. (2010), based on their primary mode of nutrition: ectomycorrhizal (ECM), soil (humus or litter) saprotrophs (SHL), wood saprotrophs (SW), and parasitic (P) species.

In addition, with reference to national (Onofri et al., 2005; Boccardo et al., 2008) and regional macrofungal check-lists (Zotti & Orsino, 2001; Zotti, et al., 2008; Zotti, et al. 2010; Ambrosio, et al., 2014), a value of geographic distribution was given for each species. Accordingly, all *taxa* were split in four classes: widespread (*w*) - species recorded in more than 65% of Italian territory; common (*c*) - species recorded in 40-65%; not common (*nc*) - species recorded in 20-40%; rare (*r*) - species recorded in less than 20% of Italian territory.

RESULTS

Altogether 39 species, out of which 9 *Ascomycota*, 29 *Basidiomycota* and 1 *Glomeromycota*, were recorded. The observed species belong to 9 different Orders, 23 Families and 32 Genera. The complete list of species is detailed in Table 1. Furthermore, some pictures are shown in Figures 4-6.

Figure 4. A) *Clavaria fragilis*; B) *Hygrocybe acutoconica*; C) *Pluteus salicinus*; D) *Pluteus romellii*. Photos by E. Ambrosio.

At the Order level, the majority of species belong to *Agaricales* and *Pezizales*; whereas *Tricholomataceae*, *Tuberaceae* and *Pluteaceae* were the most numerous group at the Family rank. *Genea*, *Lepista*, *Pluteus*, *Stereum* and *Tuber* were the richest Genera in species number.

Table 1. List of the recorded species. For each *taxon*, the following data are given: authors names, higher systematic rank (Division, Order and Family), trophic group (tg) (ECM= ectomycorrhizal; SHL= soil decay (humus or litter); SW= wood decay; P= parasitic), and, range of geographic distribution (*w*= widespread; *c*= common; *nc*= not common; *r*= rarus) at national level. Habitat or growth substratum in GBH. Species are arranged in alphabetic order according to Orders, Families and Species names.

Division	**Order**	**Family**	**Species**	**Tg**	**Distri-bution**	**Habitat/Sub-stratum in GBH**
Basidiomycota	*Agaricales*	*Amanitaceae*	*Amanita ovoidea* (Bull.) Link	ECM	*w*	Associated to broadleaf tree
Basidiomycota	*Boletales*	*Boletaceae*	*Boletus subtomentosus(* L.)	ECM	*w*	Associated to broadleaf tree
Basidiomycota	*Polyporales*	*Phanerochaetaceae*	*Byssomerulius corium* (Pers.) Parmasto	SW	*nc*	Wood
Basidiomycota	*Phallales*	*Phallaceae*	*Clathrus ruber* P. Micheli ex Pers.	SHL	*w*	Soil/litter
Basidiomycota	*Agaricales*	*Clavariaceae*	*Clavaria fragilis* Holmsk.	SHL	*w*	Soil/litter
Basidiomycota	*Agaricales*	*Psathyrellaceae*	*Coprinellus micaceus* (Bull.) Vilgalys, Hopple & Jacq. Johnson	SHL	*w*	Soil/litter
Basidiomycota	*Hymenochaetales*	*Hymenochaetaceae*	*Fuscoporia torulosa* (Pers.) T. Wagner & M. Fisch.	P	*c*	Wood of living tree
Basidiomycota	*Polyporales*	*Ganodermataceae*	*Ganoderma australe* (Fr.) Pat.	P	*c*	Wood of living tree
Basidiomycota	*Gomphales*	*Gomphaceae*	*Gautieria morchelliformis* Vittad.	ECM	*nc*	Hypogean

Division	***Order***	***Family***	***Species***	**Tg**	***Distri-bution***	**Habitat/Sub-stratum in GBH**
Ascomycota	*Pezizales*	*Pyronemataceae*	*Genea fragrans* (Wallr.) Sacc.	ECM	*nc*	Hypogean
Ascomycota	*Pezizales*	*Pyronemataceae*	*Genea verrucosa* Vittad.	ECM	*nc*	Hypogean
Glomeromycota	*Glomerales*	*Glomeraceae*	*Glomus microcarpum* Tul. & C. Tul.	ECM	*nc*	Hypogean
Basidiomycota	*Agaricales*	*Omphalotaceae*	*Gymnopus aquosus* (Bull.) Antonín & Noordel.	SHL	*c*	Bamboo forest
Ascomycota	*Pezizales*	*Helvellaceae*	*Helvella acetabulum* (L.) Quél.	SHL	*c*	Bamboo forest
Basidiomycota	*Agaricales*	*Tricholomataceae*	*Hemimycena cucullata* (Pers.) Singer	SHL	*c*	Soil/litter
Basidiomycota	*Agaricales*	*Tricholomataceae*	*Hygrocybe acutoconica* (Clem.) Singer	SHL	*nc*	Soil/litter
Basidiomycota	*Agaricales*	*Cortinariaceae*	*Inocybe splendens* R. Heim	ECM	*c*	Associated to broadleaf tree in Holm-oak wood
Basidiomycota	*Agaricales*	*Tricholomataceae*	*Lepista nuda* (Bull.) Cooke	SHL	*w*	Soil/litter
Basidiomycota	*Agaricales*	*Tricholomataceae*	*Lepista sordida* (Schumach.) Singer	SHL	*c*	Soil/litter
Basidiomycota	*Agaricales*	*Mycenaceae*	*Mycena acicula* (Schaeff.) P. Kumm.	SHL	*nc*	Soil/litter

Division	***Order***	***Family***	***Species***	**Tg**	***Distri-bution***	**Habitat/Sub-stratum in GBH**
Basidiomycota	*Agaricales*	*Psathyrellaceae*	*Parasola plicatilis* (Curtis) Redhead, Vilgalys & Hopple	SHL	*c*	Soil/litter
Ascomycota	*Pezizales*	*Pezizaceae*	*Peziza badia* Pers.	ECM	*nc*	Bamboo forest
Basidiomycota	*Polyporales*	*Phanerochaetaceae*	*Phanerochaete velutina* (DC.) P. Karst.	SW	*nc*	Wood
Basidiomycota	*Boletales*	*Sclerodermataceae*	*Pisolithus arhizus* (Scop.) Rauschert	ECM	*nc*	Associated to broadleaf tree
Basidiomycota	*Agaricales*	*Pluteaceae*	*Pluteus leoninus* (Schaeff.) P. Kumm.	SW	*nc*	Wood
Basidiomycota	*Agaricales*	*Pluteaceae*	*Pluteus romellii* (Britzelm.) Sacc.	SW	*c*	Australian forest/wood
Basidiomycota	*Agaricales*	*Pluteaceae*	*Pluteus salicinus* (Pers.) P. Kumm.	SW	*nc*	Wood
Basidiomycota	*Agaricales*	*Psathyrellaceae*	*Psathyrella candolleana* (Fr.) Maire	SHL	*w*	Soil/litter
Basidiomycota	*Gomphales*	*Gomphaceae*	*Ramaria fumigata* (Peck) Corner	ECM	*nc*	Associated to broadleaf tree
Ascomycota	*Pezizales*	*Tuberaceae*	*Reddellomyces donkii* (Malençon) Trappe, Castellano & Malajczuk	ECM	*nc*	Hypogean
Ascomycota	*Pezizales*	*Pezizaceae*	*Sarcosphaera coronaria* (Jacq.) J. Schröt.	ECM	*nc*	Associated to broadleaf tree

Division	***Order***	***Family***	***Species***	**Tg**	***Distri-bution***	**Habitat/Sub-stratum in GBH**
Basidiomycota	*Agaricales*	*Schizophyllaceae*	*Schizophyllum commune* Fr.	SW	*c*	Wood
Basidiomycota	*Russulales*	*Stereaceae*	*Stereum hirsutum* (Willd.) Pers.	SW	*c*	Wood
Basidiomycota	*Russulales*	*Stereaceae*	*Stereum ochraceoflavum* (Schwein.) Sacc.	SW	*c*	Wood
Basidiomycota	*Agaricales*	*Tricholomataceae*	*Tricholoma terreum* (Schaeff.) P. Kumm.	ECM	*c*	Associated to broadleaf tree
Basidiomycota	*Agaricales*	*Inocybaceae*	*Tubaria furfuracea* (Pers.) Gillet	SHL	*c*	Soil/litter
Ascomycota	*Pezizales*	*Tuberaceae*	*Tuber aestivum* Vittad.	ECM	*c*	Hypogean
Ascomycota	*Pezizales*	*Tuberaceae*	*Tuber brumale* Vittad.	ECM	*nc*	Hypogean
Ascomycota	*Pezizales*	*Tuberaceae*	*Tuber excavatum* Vittad.	ECM	*nc*	Hypogean

Regarding the ecological point of view, all the identified species were split into functional groups, as follows: 16 ectomycorrhizal species (ECM), 13 soil saprotrophs (SHL), 2 parasitic (P) species and 8 wood decaying (SW) fungi.

Figure 5. A) *Pisolithus tinctorius*; B) *Gautieria morchelliformis*; C) *Clathrus ruber*; D) *Stereum hirsutum*. Photos by E. Ambrosio and M. Zotti.

With the reference to national and regional macrofungal check-lists, a value of geographic distribution was given to each species. Accordingly, the highest percentage of species found corresponds to widespread and common species, such as: *Amanita ovoidea*, *Boletus subtomentosus*, *Byssomerulius corium*, *Clathrus ruber*, *Lepista nuda*, *Phanerochaete velutina* and *Psathyrella candolleana*.

It is worth noting the presence of the infrequent species *Clavaria fragilis*, *Hemimycena cucullata*, *Hygrocybe acutoconica*, *Pisolithus tinctorius*, and *Pluteus salicinus*.

Figure 6. A) *Helvella acetabulum*; B) *Sarcosphaera coronaria*; C) *Tuber excavatum*; D) *Tuber brumale*. Photos by E. Ambrosio and M. Zotti.

Moreover, the numerous records of hypogeous species should be emphasized, such as *Gautieria morchelliformis*, *Genea fragrans, G. verrucosa, Glomus microcarpum*, *Reddellomyces donkii*, *Tuber brumale*, and *T. excavatum*.

Finally, two parasitic species, *Fuscoporia torulosa* and *Ganoderma australe*, were collected.

DISCUSSION

The results obtained by the present study contribute to a greater knowledge of the macrofungal species diversity in the Hanbury Botanical Gardens. Considering the results achieved by Penzig (1884), only three macrofungal species were recorded in GBH in the past (see

Tab. 2), such as: *Agaricus* (*Marasmius*) *androsaceus*, *Agaricus* (*Amanita*) *leiocephalus*, and, *Cyphella alboviolascens*. The great majority of the listed species by Penzig (Tab. 2) referred to microfungal species and plant pathogens. Hence, our results represent the first full macrofungal check-list of GBH.

Table 2: List of the recorded fungal species by O. Penzig (1884).

Species list	**Current name**
Agaricus (*Amanita*) *leiocephalus* DC.	*Amanita leiocephala* (DC.) Pers.
Agaricus (Marasmius) androsaceus L.Fr. *var hygrometricus*	*Gymnopus androsaceus* (L.) Della Maggiora & Trassinelli
Alternaria brassicae Sacc.	*Alternaria brassicae* (Berk.) Sacc.
Alternaria tenuis Nees	*Alternaria alternata* (Fr.) Keissl.
Antennaria elaeophila Mont.	*Antennariella elaeophila* (Mont.) Bat. & Cif.
Ascochyta folliculorum n. sp.	*Ascochyta folliculorum* Penz. & Sacc.
Ascochyta passiflorae n. sp.	*Ascochyta passiflorae* Penz. & Sacc.
Ascochyta tweediana n. sp.	*Ascochyta tweediana* Penz. & Sacc.
Ascochyta ventricosa n. sp.	*Ascochyta ventricosa* Penz. & Sacc.
Asteroma reticulatum DC. Chev.	*Guignardia reticulata* (DC.) Aa
Capnodium footii Harv. ex Berk. & Desm.	*Dennisiella babingtonii* (Berk.) Bat. & Cif.
Cercospora capparidis (Corda) Sacc.	*Cercospora capparis* Sacc.
Coniosporium arundinis Sacc.	*Apiospora montagnei* Sacc.
Cyphella alboviolascens (Alb. & Schwein.) P. Karst.	*Lachnella alboviolascens* (Alb. & Schwein.) Fr.
Dendrodochium clavipes n. sp.	*Dendrodochium clavipes* Penz. & Sacc.
Diplodia acaciae n. sp.	*Diplodia acaciae* Penz. & Sacc.
Diplodia acicola Sacc. *f. araucariae*	*Diplodia acicola var. araucariae* Penz.
Diplodia minuscula n. sp.	*Microdiplodia minuscula* (Penz. & Sacc.) Allesch.
Diplodia passiflorae n. sp.	*Diplodia passiflorae* Penz. & Sacc.

Species list	**Current name**
Diplodia phyllodiorum n. sp.	*Microdiplodia phyllodiorum* (Penz. & Sacc.) Tassi
Diplodia pinnarum Passer.	*Diplodia pinnarum* Pass.
Gloeosporella pseudo-phoma n. sp.	*Gloeosporium pseudophoma* Penz. & Sacc.
Gloeosporium hians n. sp.	*Gloeosporium hians* Penz. & Sacc.
Gloeosporium intermedium Sacc.	*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.
Gloeosporium patella n. sp.	*Colletotrichum gloeosporioides* (Penz.) Penz. & Sacc.
Gloniella hakeae n. sp.	*Gloniella hakeae* Penz. & Sacc.
Graphiola phoenicus Poit.	*Graphiola phoenicis* (Moug. ex Fr.) Poit.
Macrosporium trichellum Arc. et Sacc.	*Macrosporium trichellum* (Arcang. & Sacc.) Arcang. & Sacc.
Melanconium sphaerospermum Lk.	*Arthrinium phaeospermum* (Corda) M.B. Ellis
Myrothecium roridum Tode	*Myrothecium roridum* Tode
Oidium erysiphoides Fr.	*Podosphaera fuliginea* (Schltdl.) U. Braun & S. Takam.
Peronospora viticola Berk. et Desm.	*Plasmopara viticola* (Berk. & M.A. Curtis) Berl. & De Toni
Pestalotia funerea Desm. f. *araucariae*	*Pestalotiopsis funerea* (Desm.) Steyaert
Pestalotia lignicola Cooke	*Pestalotia lignicola* Cooke
Phoma acaciae n. sp.	*Phoma acaciae* Penz. & Sacc.
Phoma acicola (Moug. & Lév.) Sacc.	*Sydowia polyspora* (Bref. & Tavel) E. Müll.
Phoma atomospora n. sp.	*Phoma atomospora* Penz. & Sacc.
Phoma brevipes n. sp.	*Dothiorella brevipes* (Penz. & Sacc.) Petr. & Syd.
Phoma hardenbergiae n. sp.	*Phoma hardenbergiae* Penz. & Sacc.
Phoma millepunctata n. sp.	*Phoma millepunctata* Penz. & Sacc.
Phoma mucipara n. sp.	*Phoma mucipara* Penz. & Sacc.
Phoma olea (DC.) Sacc.	*Coleophoma oleae* (DC.) Petr. & Syd.
Phoma passiflorea n. sp.	*Macrophoma passiflorae* McAlpine
Phyllosticta tweediana n. sp.	*Phyllosticta tweediana* Penz. & Sacc.
Pleospora calida n. sp.	*Pleospora calida* Penz. & Sacc.

Species list	**Current name**
Pleospora herbarum (Pers.) Rabenh.	*Pleospora herbarum* (Pers.) Rabenh.
Pleospora media Niessl	*Pleospora penicillus* Fuckel
Septoria mortolensis n. sp.	*Septoria mortolensis* Penz. & Sacc.
Septoria oxyspora n. sp.	*Pseudoseptoria donacis* (Pass.) B. Sutton
Septoria petiolina n. sp.	*Septoria petiolina* Penz. & Sacc.
Sphaeropsis dracaenarum n. sp.	*Aplosporella dracaenarum* (Penz. & Sacc.) Petr.
Teichospora commutata Sacc.	*Teichospora commutata* Sacc.
Teichospora inverecunda (De Not.) Sacc.	*Chaetoplea inverecunda* (De Not.) Checa
Vermicularia eryngii (Corda) FuckelFuck.	*Vermicularia eryngii* (Corda) Fuckel
Vermicularia trichella Fr.	*Colletotrichum trichellum* (Fr.) Duke
Zignoella hanburiana n. sp.	*Zignoëlla hanburiana* Penz. & Sacc.

Note: the acronym "n. sp." refers to "new species".

Despite the fact that the surveys were performed in a limited time period, interesting *taxa* were recorded in this site.

A worthy note is the recording of very interesting and uncommon hypogeous species within *Ascomycota*, such as: *Genea fragrans, G. verrucosa*, *Reddellomyces donki*, *Tuber aestivum*, *T. brumale*, and *T. excavatum*. According to their distribution at regional scale (Zotti et al., 2010), these species are well developed in Liguria, especially in the province of Imperia (IM). More precisely, both *Glomus microcarpum* and *Gautieria morchelliformis* were recorded in Liguria only in the area of Ventimiglia (IM province) (Zotti et al., 2010).

Some aphyllophoraceous species were also found, such as: *Byssomerulius corium, Phanerochaete velutina* and *Stereum ochraceoflavum* (see Tab. 1). Within the *Aphyllophorales* s.l. group, corticiod fungi were often overlooked in previous Ligurian mycological studies (Zotti & Orsino, 2001; Zotti et al., 2008) and scarcely investigated (and listed) at national level (Onofri et al., 2005). Hence, these records allow us to increase the knowledge on their presence and distribution in the Italian territory (Bernicchia & Gorjón, 2010; Ambrosio et al., 2014)

With reference to national macrofungal check-list (Onofri et al. 2005) and report (Boccardo et al., 2008) the presence of *Hygrocybe acutoconica*, *Pisolithus arrhizus* and *Ramaria fumigata* should be emphasised as these specie were only recorded in few regions of Italy.

At an ecological level, the majority of the recorded species belong to ECM fungal group (16 sp.) followed by soil saprotrophs (SHL= 13 sp.). The percentage of wood decaying fungi (SW) and parasitic (P) species were very low. According to several European studies on forest damage (Jakucs, 1988; Arnolds, 1991; Amaranthus, 1999; Tóth & Barta, 2010), our results, which emphasise a higher presence of ECM species than wood decaying fungi, allow us to classify this sites as a "healthy" habitat.

It is worth noting the recording of *Gymnopus aquosus*, *Helvella acetabulum* and *Peziza badia* (Fig. 6) in the bamboo forest, as well as *Pluteus romellii* (Fig. 4) in the Australian forest. Despite this saprotroph species (with the exception for *H. acetabulum*, this being an ECM species, Tedersoo et al., 2010) are able to grow on different litter types, these findings increase the knowledge on their distributional range. These aforementioned species are described in literature (i.e. Boccardo et al., 2008) common in broadleaf habitats on the Italian territory.

Finally, regarding the association of the recorded macrofungal species with the collections in GBH, it should be noted that the great majority of fungi (mainly ECM species) were recorded both in the forested areas (e.g. the Mediterranean maquis) and the exotic collections (e.g. the Australian and the bamboo forest), rather than in other habitat types or areas of GBH (Tab. 1).

CONCLUSIONS

Among numerous Italian and foreign gardens the Hanbury Botanic Gardens represent an exceptional climatised area where exotic plants arriving from all regions of the world, live together in the open air even though they are out of their natural environment.

From our preliminary results it is possible to observe that several interesting macrofungi occur in the site also.

Future mycological investigations need to be planned in order to improve the knowledge on the mycobiota of GBH and to understand if there exists a particular mycoflora associated with plant collections, as well as to investigate the presence and the correlation of fungi (e.g. endophytes) with exotic plant species.

Plant conservation actions cannot be implemented without a complete knowledge on diversity and interactions between plants and other living organisms, such as fungi.

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