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# Preliminary checklist of the macrofungi from northwestern Tunisia

**Ben Hassine Ben Ali M[1*] and Stephenson SL[1]**

[1] Department of Biological Sciences, University of Arkansas, Fayetteville, Arkansas 72701

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**Abstract**

A preliminary checklist of the species of macrofungi recorded from northwestern Tunisia is provided. The data presented herein, based on collections made over a period of two years, highlight the importance of macrofungal diversity in Tunisia. A total of 331 sporocarps representing 126 species belonging to 11 orders and 40 families were collected. The most important families were the Agaricaceae (16 species), Russulaceae (15 species), Cortinariaceae (9 species), Tricholomotaceae (9 species) and Amanitaceae (8 species). The results obtained contribute to what is known about macrofungal diversity of Tunisia, which remains understudied.

**Key words** – Aïn Draham – *Quercus* – sporocarps – taxonomy

## Introduction

Fungi are estimated at 0.8 million to 5.1 million species worldwide (Blackwell 2011). However, less than 5% of species have been described (Hawksworth & Mueller 2005). Fungi occur in almost all habitats, surpassed only by bacteria in their ability to withstand extremes in temperature, availability of water, and limited carbon resources. Fungi have a profound impact on the functioning of global ecosystems (Blackwell et al. 2006). They enhance plant growth and produce valuable biochemicals such as ethanol and various antibiotics. Fungi can also enhance the capability of the plants to take up and utilize nutrients, strengthen the self-defense ability of plants, promote plant growth, and improve soil quality (Zhang et al. 2010). Macrofungi are distinguished from microfungi by having spore-bearing structures (sporocarps) visible to the naked eye, and the group includes such examples as mushrooms, bracket fungi, puffballs, false truffles and cup fungi. Most macrofungi belongs to the Ascomycota or Basidiomycota, but a few are members of the Zygomycota (Mueller et al. 2007). In forest ecosystems, macrofungi may function as decomposers of organic matter, form mycorrhizal associations with trees occur as parasites or pathogens and/or are food resources for various organisms (Crabtree et al. 2010). Some examples also represent an important resource as high-quality food for humans, with a significant economic value (Zhang et al. 2010). Despite this wealth, mycological studies in Tunisia have been very limited. Since Malençon (1952) published the results of his studies of Tunisian macrofungi, there has not been any complementary research updating the assemblage of macrofungi found in northwestern Tunisia. However, several mycological studies have taken place in adjacent countries such as Algeria and Morocco, and these revealed a high diversity of macrofungi (Djelloul et al. 2010, N'Douba et al. 2013, Nounsi et al. 2014). In order to contribute to the knowledge of the macrofungi present in Tunisia, a preliminary checklist of macrofungi recorded to date was assembled.

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Corresponding Author: Ben Hassine Ben Ali M – e-mail – benhassine.doc@gmail.com

## Materials and Methods

The country of Tunisia is located on the Mediterranean coast of North Africa and is bordered by Algeria on the west and Libya on the southeast. Northwestern Tunisia is characterized by a typical Mediterranean climate, with hot, dry summers and mild winters with moderate rainfall. The average annual temperature is 14.9°C, while the average maximum of the hottest month (August) is 37°C and the average minimum of the coldest month (January) is 3.8°C. The absolute minimum (5°C) for the region is recorded in the months of December and February, whereas the absolute maximum (43°C) occurs in August. Mean annual rainfall is less than 500 mm for virtually the entire country. Northwestern Tunisia contains coniferous and mixed forests that can be found in the Kroumerie and Mogod Mountain Ranges, which reach an elevation of approximately 1,000 m (Stambouli et al. 2007). The study reported herein was carried out in the general area of Ain Draham (36°46′ N latitude and 8°42′ E longitude) (Fig. 1). The topsoil of this portion of Tunisia tends to be a sandy loam or sandy-clay loam in the A horizon. The forests in this region of the country are characterized by a mixture of species both the shrub layer and the canopy. Oaks (*Quercus* spp.) are the most common trees (Fig. 2). *Quercus suber* L. (cork oak) and *Quercus faginea* Lam. (Portuguese oak) are found on all sites along with *Pinus pinaster* L. (maritime pine). Since all three trees are ectomycorrhizal, they are associated with an assemblage of ectomycorrhizal-forming fungi. The shrub layer is characterized by the presence of such species as *Arbutus unedo* L., *Myrtus communis* L., *Erica arborea* L., *Crataegus monogyna* L., *Calycotome villosa* Link., *Cistus monspeliensis* L., *Daphne gnidium* L. and *Rubus ulmifolius* Schott.

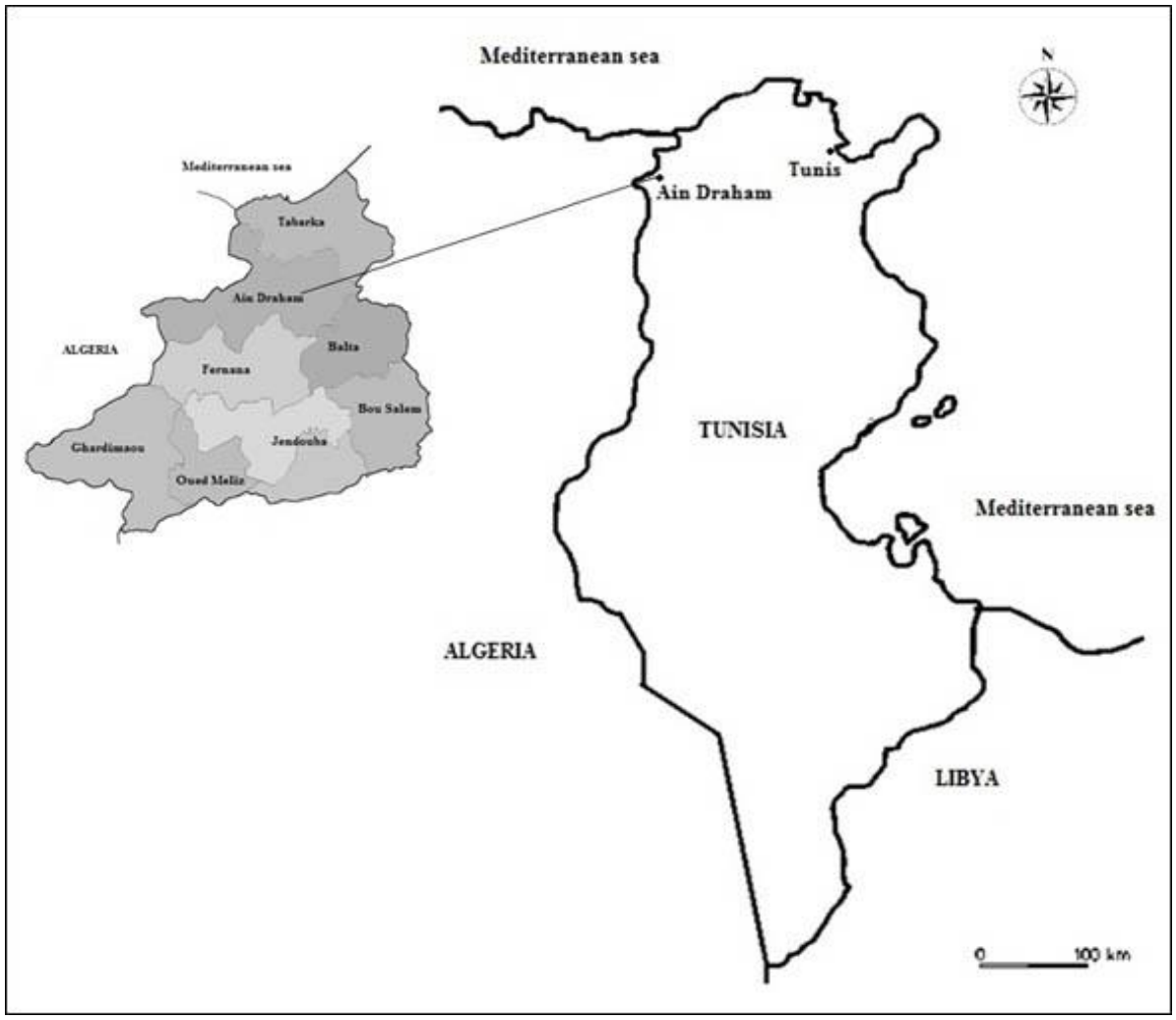


**Fig. 1 –** Location of the study area in the Aïn Draham region of northwestern Tunisia.

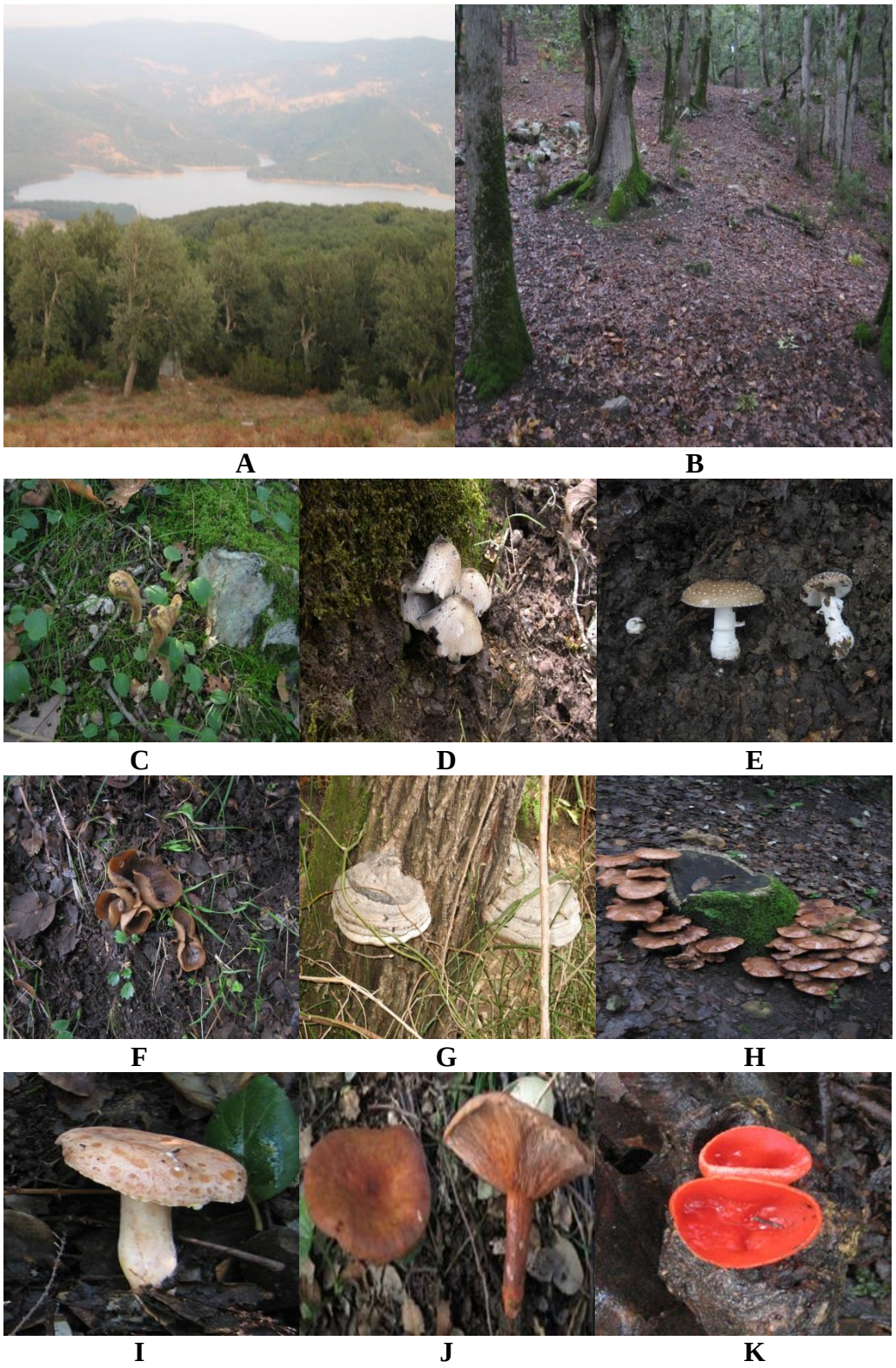


**Fig. 2A-K** – General aspect of the study area and the diversity of the macrofungi present. **A** Landscape view of the forests of northwestern Tunisia. **B** Forest interior. **C** *Clavariadelphus occidentalis.* **D** *Coprinus comatus*. **E** *Amanita pantherina*. **F** *Auricularia auricula-judae*. **G** *Lactarius fulvissimus*. **H** *Armillaria mellea*. **I** *Lactarius chrysorrheus*. **J** *Lactarius fulvissimus*. **K** *Sarcoscypha coccinea*.


**Fig. 2L-X –** Other macrofungi collected in northwestern Tunisia. **L** *Scleroderma verrucosum*. **M** *Hydnellum concrescens*. **N** *Ramaria flavescens*. **O** *Clavulina cristata*. **P** *Hydnum ovoideisporum*. **Q** *Clavariadelphus occidentalis*. **R** *Cantharellus cibarius*. **S** *Amanita rubescens*. **T** *Craterellus cornucopioides*. **U** *Amanita citrina*. **V** *Boletus reticulatus*. **W** *Macrolepiota rickenii*. **X** *Bjerkandera adusta*. **Y** *Lactarius vellereus*. **Z** *Galerina marginata*.

## Collecting Methods

The checklist of macrofungi that follows (Table 1) is based upon specimens collected during two years of collecting. The ecological and morphological characteristics of the sporocarps were recorded and they were photographed in their natural habitats (Fig. 2). In addition, the type of tree with which sporocarps were associated was recorded. Sporocarps were tallied and identified using macroscopic characters and field guides, including *Guide Vigot des Champignons* (Gerhardt 1999). All sporocarps were preserved by drying at room temperature. In the checklist, macrofungi are listed alphabetically first by genus and then by species in the major taxonomic groups to which they belong. Relative abundance, based on the relative numbers of sporocarps, was recorded for each species. Species which represented by more than six sporocarps were considered as abundant, those represented by 2-5 sporocarps were considered as occasional, and any species represented by a single sporocarp was classified as rare.

## Results

The results obtained in the present study clearly indicate the high level of diversity for macrofungal in northwestern Tunisia. A total 126 species were collected, including 72 species of ectomycorrhizal fungi, 48 saprotrophic species, three parasitic species and three saprotrophic-parasitic species (Table 1). The abundant species were *Armillaria mellea*, *Bjerkandera adusta*, *Cantharellus cibarius*, *Hydnum rufescens*, *Ramaria flavescens* and *Sarcoscypha coccinea*.

**Table 1** Macrofungi recorded from northwestern Tunisia. Note: Rare = 1 sporocarp, Occasional = 2 to 5 sporocarps, Abundant = ≥ 6 sporocarps, Qs = *Quercus suber*, Qf = *Quercus faginea*, and Mixed = mixture of *Calycotome villosa*, *Crataegus monogyna*, *Cistus monspeliensis* and *Erica arborea*.

| Species | Relative abundance | Biological role | Associated tree(s) |
|---|---|---|---|
| **Division Agaricomycotina** | | | |
| **Class Agaricomycetes** | | | |
| **Order Agaricales** | | | |
| **Family Mycenaceae** | | | |
| *Mycena galopus* (Pers.) P. Kumm. | Occasional | Saprotrophic | Qs/Qf |
| *Mycena inclinata* (Fr.) Quél. | Rare | Saprotrophic | Qs/Qf |
| **Family Agaricaceae** | | | |
| *Agaricus arvensis* Schaeff. | Occasional | Saprotrophic | Mixed/Qs/Qf |
| *Agaricus bisporus* (J.E. Lange) Imbach | Rare | Saprotrophic | Mixed/Qs/Qf |
| *Agaricus campestris* L. | Rare | Saprotrophic | Mixed/Qs/Qf |
| *Agaricus impudicus* (Rea) Pilát | Rare | Saprotrophic | Mixed/Qs/Qf |
| *Agaricus subperonatus* (J.E. Lange) Singer | Rare | Saprotrophic | Mixed/Qs/Qf |
| *Bovista pila* Berk. & M.A. Curtis | Occasional | Saprotrophic | Qs/Qf |
| *Bovista plumbea* Pers. | Occasional | Saprotrophic | Qs/Qf |
| *Coprinus comatus* (O.F. Müll.) Pers. | Occasional | Saprotrophic | Qs/Qf |
| *Coprinus flocculosus* (DC.) Fr. | Occasional | Saprotrophic | Qs/Qf |
| *Lepiota excoriata* (Schaeff.) P. Kumm. | Occasional | Saprotrophic | Qs/Qf |
| *Lepiota procera* (Scop.) Gray | Occasional | Saprotrophic | Qs/Qf |
| *Lycoperdon molle* Pers. | Occasional | Saprotrophic | Qs/Qf |
| *Lycoperdon nigrescens* Pers. | Occasional | Saprotrophic | Qs/Qf |
| *Lycoperdon perlatum* Pers. | Occasional | Saprotrophic | Qs/Qf |
| *Macrolepiota mastoidea* (Fr.) Singer | Occasional | Saprotrophic | Mixed/Qs/Qf |
| *Macrolepiota rickenii* (Velen.) Bellù & Lanzoni | Rare | Saprotrophic | Mixed/Qs/Qf |
| **Family Pluteaceae** | | | |
| *Pleurotus dryinus* (Pers.) P. Kumm. | Occasional | Saprotrophic | Qs/Qf |
| *Pleurotus opuntiae* (Durieu & Lév.) Sacc. | Occasional | Saprotrophic | Qs/Qf |
| *Pleurotus ostreatus* (Jacq.) P. Kumm. | Occasional | Saprotrophic | Qs/Qf |
| *Pluteus cervinus* (Schaeff.) P. Kumm. | Occasional | Saprotrophic | Qs/Qf |

| Species | Relative abundance | Biological role | Associated tree(s) |
|---|---|---|---|
| **Family Amanitaceae** | | | |
| *Amanita caesarea* (Scop.) Pers. | Occasional | Ectomycorrhizal | Qs |
| *Amanita citrina* Pers. | Occasional | Ectomycorrhizal | Qs |
| *Amanita fulva* Fr. | Rare | Ectomycorrhizal | Qs |
| *Amanita pantherina* (DC.) Krombh. | Occasional | Ectomycorrhizal | Qs |
| *Amanita phalloides* (Vaill. ex Fr.) Link | Occasional | Ectomycorrhizal | Qs |
| *Amanita rubescens* Pers. | Occasional | Ectomycorrhizal | Qs |
| *Amanita vaginata* (Bull.) Lam. | Rare | Ectomycorrhizal | Qs |
| *Amanita verna* (Bull.) Lam. | Rare | Ectomycorrhizal | Qs |
| **Family Physalacriaceae** | | | |
| *Armillaria mellea* (Vahl) P. Kumm. | Abundant | Parasitic | Qs/Qf |
| *Armillariella ostoyae* Romagn. | Occasional | Parasitic | Qs/Qf |
| **Family Lyophyllaceae** | | | |
| *Calocybe gambosa* (Fr.) Singer | Rare | Ectomycorrhizal | Qs/Qf |
| **Family Cortinariaceae** | | | |
| *Cortinarius anomalus* (Fr.) Fr. | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius caninus* (Fr.) Fr. | Rare | Ectomycorrhizal | Qs |
| *Cortinarius cephalixus* Secr. ex Fr. | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius cf. obtusus* (Fr.) Fr. | Rare | Ectomycorrhizal | Qs |
| *Cortinarius contractus* Rob. Henry | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius infractus* (Pers.) Fr. | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius phoeniceus* (Vent.) Maire | Occasional | Ectomycorrhizal | Qs |
| *Galerina marginata* (Batsch) Kühner | Occasional | Saprotrophic | Qs |
| *Hebeloma cavipes* Huijsman | Rare | Ectomycorrhizal | Qs |
| **Family Omphalotaceae** | | | |
| *Lentinula edodes* (Berk.) Pegler | Occasional | Saprotrophic | Qs/Qf |
| **Family Inocybaceae** | | | |
| *Inocybe sindonia* (Fr.) P. Karst. | Rare | Ectomycorrhizal | Qs/Qf |
| **Family Clavariaceae** | | | |
| *Clavaria cristata* (Holmsk.) Pers. | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| *Clavulinopsis fusiformis* (Sowerby) Corner | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| *Clavulinopsis helvola* (Pers.) Corner | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| **Family Entolomataceae** | | | |
| *Entoloma lividum* Quél. | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| **Family Hygrophoraceae** | | | |
| *Hygrocybe coccinea* (Schaeff.) P. Kumm. | Occasional | Saprotrophic | Qs/Qf |
| *Hygrophorus agathosmus* (Fr.) Fr. | Rare | Ectomycorrhizal | Qs |
| *Macrolepiota rickenii (Velen.) Bellù & Lanzoni* | Rare | Saprotrophic | Mixed/Qs/Qf |
| *Family Pluteaceae* | | | |
| *Pleurotus dryinus (Pers.) P. Kumm.* | Occasional | Saprotrophic | Qs/Qf |
| *Pleurotus opuntiae (Durieu & Lév.) Sacc.* | Occasional | Saprotrophic | Qs/Qf |
| *Pleurotus ostreatus (Jacq.) P. Kumm.* | Occasional | Saprotrophic | Qs/Qf |
| *Pluteus cervinus (Schaeff.) P. Kumm.* | Occasional | Saprotrophic | Qs/Qf |
| *Family Amanitaceae* | | | |
| *Amanita caesarea (Scop.) Pers.* | Occasional | Ectomycorrhizal | Qs |
| *Amanita citrina Pers.* | Occasional | Ectomycorrhizal | Qs |
| *Amanita fulva Fr.* | Rare | Ectomycorrhizal | Qs |
| *Amanita pantherina (DC.) Krombh.* | Occasional | Ectomycorrhizal | Qs |
| *Amanita phalloides (Vaill. ex Fr.) Link* | Occasional | Ectomycorrhizal | Qs |
| *Amanita rubescens Pers.* | Occasional | Ectomycorrhizal | Qs |
| *Amanita vaginata (Bull.) Lam.* | Rare | Ectomycorrhizal | Qs |
| *Amanita verna (Bull.) Lam.* | Rare | Ectomycorrhizal | Qs |
| *Family Physalacriaceae* | | | |
| *Armillaria mellea (Vahl) P. Kumm.* | Abundant | Parasitic | Qs/Qf |
| *Armillariella ostoyae Romagn.* | Occasional | Parasitic | Qs/Qf |
| *Family Lyophyllaceae* | | | |

| Species | Relative abundance | Biological role | Associated tree(s) |
|---|---|---|---|
| *Calocybe gambosa (Fr.) Singer* | Rare | Ectomycorrhizal | Qs/Qf |
| *Family Cortinariaceae* | | | |
| *Cortinarius anomalus (Fr.) Fr.* | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius caninus (Fr.) Fr.* | Rare | Ectomycorrhizal | Qs |
| *Cortinarius cephalixus Secr. ex Fr.* | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius cf. obtusus (Fr.) Fr.* | Rare | Ectomycorrhizal | Qs |
| *Cortinarius contractus Rob. Henry* | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius infractus (Pers.) Fr.* | Occasional | Ectomycorrhizal | Qs |
| *Cortinarius phoeniceus (Vent.) Maire* | Occasional | Ectomycorrhizal | Qs |
| *Galerina marginata (Batsch) Kühner* | Occasional | Saprotrophic | Qs |
| *Hebeloma cavipes Huijsman* | Rare | Ectomycorrhizal | Qs |
| *Family Omphalotaceae* | | | |
| *Lentinula edodes (Berk.) Pegler* | Occasional | Saprotrophic | Qs/Qf |
| *Family Inocybaceae* | | | |
| *Inocybe sindonia (Fr.) P. Karst.* | Rare | Ectomycorrhizal | Qs/Qf |
| *Family Clavariaceae* | | | |
| *Clavaria cristata (Holmsk.) Pers.* | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| *Clavulinopsis fusiformis (Sowerby) Corner* | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| *Clavulinopsis helvola (Pers.) Corner* | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| *Family Entolomataceae* | | | |
| *Entoloma lividum Quél.* | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| *Family Hygrophoraceae* | | | |
| *Hygrocybe coccinea (Schaeff.) P. Kumm.* | Occasional | Saprotrophic | Qs/Qf |
| *Hygrophorus agathosmus (Fr.) Fr.* | Rare | Ectomycorrhizal | Qs |
| *Hygrophorus cossus (Sowerby) Fr.* | Occasional | Ectomycorrhizal | Qs |
| *Hygrophorus erubescens (Fr.) Fr.* | Occasional | Ectomycorrhizal | Qs |
| *Hygrophorus russula (Schaeff.) Kauffman* | Rare | Ectomycorrhizal | Qs |
| *Family Tricholomataceae* | | | |
| *Clitocybe gibba (Pers.) P. Kumm.* | Rare | Saprotrophic | Qs/Qf |
| *Collybia fusipes (Bull.) Quél.* | Occasional | Saprotrophic | Qs/Qf |
| *Collybia impudica (Fr.) Singer* | Occasional | Saprotrophic | Qs/Qf |
| *Tricholoma atrosquamosum Sacc.* | Occasional | Ectomycorrhizal | Qs |
| *Tricholoma columbetta (Fr.) P. Kumm.* | Occasional | Ectomycorrhizal | Qs |
| *Tricholoma saponaceum (Fr.) P. Kumm.* | Occasional | Ectomycorrhizal | Qs |
| *Tricholoma sejunctum (Sowerby) Quél.* | Occasional | Ectomycorrhizal | Qs |
| *Tricholoma sulphureum (Bull.) P. Kumm.* | Rare | Ectomycorrhizal | Qs |
| *Tricholoma terreum (Schaeff.) P. Kumm.* | Occasional | Ectomycorrhizal | Qs |
| *Family Psathyrellaceae* | | | |
| *Coprinopsis insignis (Peck) Redhead, Vilgalys & Moncalvo* | Occasional | Saprotrophic | Mixed/Qs/Qf |
| *Family Schizophyllaceae* | | | |
| *Schizophyllum commune Fr.* | Occasional | Parasitic | Qs/Qf |
| *Order Auriculariales* | | | |
| *Family Diplocystidiaceae* | | | |
| *Astraeus hygrometricus (Pers.) Morgan* | Occasional | Ectomycorrhizal | Mixed/Qs/Qf |
| *Order Polyporales* | | | |
| *Family Auriculariaceae* | | | |
| *Auricularia auricula-judae (Bull.) Quél.* | Occasional | Saprotrophic | Qs/Qf |
| *Family Meruliaceae* | | | |
| *Bjerkandera adusta (Willd.) P. Karst.* | Abundant | Saprotrophic | Qs/Qf |
| *Family Fomitopsidaceae* | | | |
| *Fomitopsis pinicola (Sw.) P. Karst.* | Occasional | Saprotrophic | Qs/Qf |
| *Family Polyporaceae* | | | |

| Species | Relative abundance | Biological role | Associated tree(s) |
|---|---|---|---|
| *Trametes multicolor (Schaeff.) Jülich* | Occasional | Saprotrophic | Qs/Qf |
| *Trametes versicolor (L.) Lloyd* | Rare | Saprotrophic | Qs/Qf |
| *Family Sparassidaceae* | | | |
| *Sparassis brevipes Krombh.* | Rare | Saprotrophic/ Parasitic | Qs/Qf |
| *Sparassis crispa (Wulfen) Fr.* | Rare | Saprotrophic/ Parasitic | Qs/Qf |
| *Order Boletales* | | | |
| *Family Boletaceae* | | | |
| *Boletus edulis Bull.* | Rare | Ectomycorrhizal | Qs |
| *Boletus luteus L.* | Occasional | Ectomycorrhizal | Qs |
| *Boletus reticulatus Schaeff.* | Rare | Ectomycorrhizal | Qs |
| *Boletus satanas Lenz* | Occasional | Ectomycorrhizal | Qs |
| *Leccinum quercinum (Pilát) E.E. Green & Watling* | Rare | Ectomycorrhizal | Qs |
| *Strobilomyces strobilaceus (Scop.) Berk.* | Rare | Ectomycorrhizal | Qs |
| *Family Suillaceae* | | | |
| *Suillus grevillei (Klotzsch) Singer* | Rare | Ectomycorrhizal | Qs |
| *Suillus luteus (L.) Roussel* | Rare | Ectomycorrhizal | Qs |
| *Xerocomus badius (Fr.) E.-J. Gilbert* | Occasional | Ectomycorrhizal | Qs |
| *Xerocomus chrysenteron (Bull.) Quél.* | Rare | Ectomycorrhizal | Qs |
| *Family Gyroporaceae* | | | |
| *Gyroporus cyanescens (Bull.) Quél.* | Rare | Saprotrophic | Qs/Qf |
| *Family Sclerodermataceae* | | | |
| *Scleroderma verrucosum (Bull.) Pers.* | Occasional | Ectomycorrhizal | Qs/Qf |
| *Family Paxillaceae* | | | |
| *Paxillus panuoides (Fr.) Fr.* | Occasional | Saprotrophic | Qs/Qf |
| *Order Cantharellales* | | | |
| *Family Cantharellaceae* | | | |
| *Craterellus cornucopioides (L.) Pers.* | Occasional | Ectomycorrhizal | Qs |
| *Cantharellus cibarius Fr.* | Abundant | Ectomycorrhizal | Qs |
| *Cantharellus lutescens Fr.* | Ra | Ectomycorrhizal | Qs |
| *Family Hydnaceae* | | | |
| *Hydnum ovoideisporum Olariaga, Grebenc, Salcedo & M.P. Martín* | Occasional | Ectomycorrhizal | Qs |
| *Hydnum repandum L.* | Occasional | Ectomycorrhizal | Qs |
| *Hydnum rufescens Schaeff.* | Abundant | Ectomycorrhizal | Qs |
| *Family Clavulinaceae* | | | |
| *Clavulina cinerea (Bull.) J. Schröt.* | Occasional | Saprotrophic | Qs/Qf |
| *Clavulina cristata (Holmsk.) J. Schröt.* | Occasional | Saprotrophic | Qs/Qf |
| *Clavulina rugosa (Bull.) J. Schröt.* | Occasional | Saprotrophic | Qs/Qf |
| *Order Gomphales* | | | |
| *Family Clavariadelphaceae* | | | |
| *Clavariadelphus pistillaris (L.) Donk* | Occasional | Saprotrophic | Mixed/Qs/Qf |
| *Clavariadelphus ligula (Schaeff.) Donk* | Occasional | Saprotrophic | Mixed/Qs/Qf |
| *Clavariadelphus occidentalis Methven* | Rare | Saprotrophic | Mixed/Qs/Qf |
| *Family Gomphaceae* | | | |
| *Ramaria aurea (Schaeff.) Quél.* | Rare | Ectomycorrhizal | Qs/Qf |
| *Ramaria flava (Schaeff.) Quél.* | Occasional | Ectomycorrhizal | Qs/Qf |
| *Ramaria flavescens (Schaeff.) R.H. Petersen* | Abundant | Ectomycorrhizal | Qs/Qf |
| *Family Polyporaceae* | | | |
| *Coriolus versicolor (L.) Quél.* | Occasional | Saprotrophic | Qs/Qf |
| *Order Pezizales* | | | |
| *Family Helvellaceae* | | | |
| *Helvella elastica Bull.* | Occasional | Saprotrophic | Qs |
| *Helvella lacunosa Afzel.* | Occasional | Saprotrophic | Qs |
| **Family Morchellaceae** | | | |
| *Morchella conica* Pers. | Rare | Ectomycorrhizal | Mixed/Qs/Qf |

| Species | Relative abundance | Biological role | Associated tree(s) |
|---|---|---|---|
| *Morchella esculenta var. crassipes* (Vent.) Bresinsky & Stangl | Rare | Ectomycorrhizal | Mixed/Qs/Qf |
| *Morchella rotunda* (Pers.) Boud. | Rare | Ectomycorrhizal | Mixed/Qs/Qf |
| **Family Sarcoscyphaceae** | | | |
| *Sarcoscypha coccinea* (Jacq.) Sacc. | Abundant | Saprotrophic | Mixed/Qs |
| **Order Thelephorales** | | | |
| **Family Bankeraceae** | | | |
| *Hydnellum concrescens* (Pers.) Banker | Rare | Ectomycorrhizal | Qs |
| **Order Russulales** | | | |
| **Family Russulaceae** | | | |
| *Lactarius chrysorrheus* Fr. | Occasional | Ectomycorrhizal | Qs |
| *Lactarius deliciosus* (L.) Gray | Occasional | Ectomycorrhizal | Qs |
| *Lactarius fulvissimus* Romagn | Occasional | Ectomycorrhizal | Qs |
| *Lactarius piperatus* (L.) Pers. | Occasional | Ectomycorrhizal | Qs |
| *Lactarius quietus* (Fr.) Fr. | Occasional | Ectomycorrhizal | Qs |
| *Lactarius subumbonatus* Lindgr | Rare | Ectomycorrhizal | Qs |
| *Lactarius vellereus* (Fr.) Fr. | Occasional | Ectomycorrhizal | Qs |
| *Russula amoena* Quél. | Occasional | Ectomycorrhizal | Qs |
| *Russula cyanoxantha* (Schaeff.) Fr. | Occasional | Ectomycorrhizal | Qs |
| *Russula delica* Fr. | Occasional | Ectomycorrhizal | Qs |
| *Russula emetica* (Schaeff.) Pers. | Rare | Ectomycorrhizal | Qs |
| *Russula lepida* Fr. | Occasional | Ectomycorrhizal | Qs |
| *Russula turci* Bres. | Occasional | Ectomycorrhizal | Qs |
| *Russula virescens* (Schaeff.) Fr. | Occasional | Ectomycorrhizal | Qs |
| *Russula viscida* Kudřna | Rare | Ectomycorrhizal | Qs |
| **Family Stereaceae** | | | |
| *Stereum hirsutum* (Willd.) Pers. | Occasional | Saprotrophic | Qs/Qf |
| **Order Tremellales** | | | |
| **Family Tremellaceae** | | | |
| *Tremella mesenterica* Retz. | Occasional | Saprotrophic | Qs |
| **Order Hymenochaetales** | | | |
| **Family Hymenochaetaceae** | | | |
| *Phellinus igniarius* (L.) Quél. | Occasional | Saprotrophic /Parasitic | Qs |
| **Family Strophariaceae** | | | |
| *Pholiota carbonaria* A.H. Sm. | Occasional | Ectomycorrhizal | Mixed |

## Discussion

The majority of species collected in this study were associated with *Quercus*, which is known to be an ectomycorrhizal host for many species of ectomycorrhizal-forming macrofungi (O'Hanlon & Harrington 2012). Documenting the macrofungal flora of northwestern Tunisia should provide useful information for future ecological studies, since there are a number of important interactions between macrofungi and plants.

It should be noted that the identification procedures used for macrofungi rely almost solely on morphological features of sporocarps, and this can be difficult for species that are very similar in appearance. Molecular methods such as PCR-sequencing can help with the identification of macrofungi, since the classical methods require considerably more taxonomic expertise. In fact, molecular methods were developed in early 1990s for macrofungi identification using the nuclear ribosomal internal transcribed spacer region (ITS) because of its wide taxonomic applicability (White et al. 1990; Gardes & Bruns 1993). The list of macrofungi generated in this study provides a body of baseline information on the species present in northwestern Tunisia. It represents an important first step towards producing a more comprehensive inventory of macrofungi for the entire country. For the most part, the ultimate importance of macrofungi relates the dynamics of the ecosystems in which they occur, but some species are consumed by humans. Additional surveys for Tunisian macrofungi should be carried out in other portions of the country, especially in arid and semi-arid regions where desert truffles, edible fungi known for their gastronomic value, are known to occur.

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