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The first check-list of macro-fungi in Tlemcen Wilaya (North-West of Algeria) reveals the discovery of 5 new records for Algeria

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Abstract

This study constitutes a contribution to the enrichment of the Algerian as well as the North African fungal lists. Based on the morphological identification of the collected specimens and both on the exploitation of recent surveys and historical scientific literature. The current survey provides the first checklist of macromycetes of the wilaya of Tlemcen in the North-West of Algeria. A total of 54 fungal species were inventoried, which are classified into 40 genera and 28 families belonging to 11 orders, hence providing a better knowledge of their diversity and ecology in their natural biotopes. Five mushrooms are recorded in Algeria for the first time.
Keywords: Fungal diversity; Mushrooms, Inventory; List; New record.

الملخص

تشكل هذه الدراسة مساهمة في إثراء قائمة الفطريات الجزائرية وكذا قوائم شمال إفريقيا بناءً على التحديدات الظاهرية أو المورفولوجية للعينات التي تم جمعها وعلى كل من إستغلال الدراسات العلمية الحديثة والسابقة. تقدم الدراسة الحالية أول قائمة مرجعية للفطريات العليا لولاية تلمسان في غرب الجزائر. تم جرد ما مجموعه 54 نوعًا من الفطريات، والتي تم تصنيفها إلى 40 صنفًا و28 عائلة تنتمي إلى 11 رتبة، مما يوفر معرفة أفضل بتنوعها البيولوجي في بيئاتها الحيوية الطبيعية. تم كذلك تسجيل لأول مرة خمس أنواع جديدة من الفطريات العليا في الجزائر.
الكلمات المفتاحية :التنوع الفطري؛ الفطريات؛ الجرد؛ لائحة؛ تسجيل جديد .

Introduction

Fungi, these living organisms, neither animals nor plants, with a hidden life cycle, constitute a kingdom of their own, ensuring an essential role in the proper functioning of ecosystems. They recycle nutrients, decompose wood and also, they form mycorrhizae which promote plant growth. Their presence is linked to forest species that constitute a selected population in harmony with the environment (Wijayawardene et al., 2018; Raven et al., 2014). Fungi do not form a homogeneous group; however, they share some fundamental characteristics, such as in eukaryotes, their chromosomes are enclosed in a nucleus (with many variations in the number of nuclei). Heterotrophs, unable to produce their own organic matter, they are forced to feed at the expense

of pre-existing organic constituents. They feed by absorbing directly, through their walls, food present in a dissolved state in the environment. Their somatic (or vegetative) body is known as a thallus, also called mycelium in the most evolved forms, filamentous (except for yeasts). They reproduce by spores. Their spores are not flagellated (exceptionally with a flagellum for some Chytridiomycota or some Neocallimastigomycota). The cell wall is formed of chitin. They have other characteristics in common, carbohydrate reserves in the form of glycogen and the production of a specific sugar, trehalose (Roland et al., 2008; Courtecuisse and Duhem, 2013; Martin, 2014; Raven et al., 2014; Lecointre and Guyader, 2016; Eyssartier and Pierre, 2017; Zhang et al., 2017; McNeil, 2019). Ecologically, heterotrophy results in the occupation of particular niches and three main ways of life or types of relationships: saprophytic (role of decomposer of dead plant or animal organisms), symbiosis (associated with algae or cyanobacteria to form lichens, or association with roots of Phanerogams to form mycorrhizal), and parasitism, which often leads to diseases (their nutrition from living matter) (Knudsen and Petersen, 2005; Nabors, 2008; Fricker et al., 2017; Sipos et al., 2017).

They constitute a perfect biological valorization of waste. In nature, fungi are indispensable decomposers. They participate in the decomposition and transformation of dead or living matter. They have diversified enzymatic (exoenzymes) equipment, allowing them to degrade an infinite number of substrates (including cellulose and lignin). Fungi carry out decomposition by secreting enzymes that reduce complex organic compounds into simpler molecules that they can absorb. (Kohler et al., 2015; Lutzoni et al., 2018; Hyde et al., 2019). Fungal classification characters have evolved from traditional taxonomy based on morphology, including macroscopic, microscopic, ecological, and other observable phenotypic features. Then, with the development of electron microscopy techniques, fungal ultra-structures, such as cell walls and septa, have been used. As a result of technological progress, many biochemical and physiological techniques have been implemented (such as chemical assays and secondary metabolites). More recently, the use of molecular phylogenetic approaches is currently necessary (protein, DNA, and RNA sequences). The present classification takes into account all characters (Guarro et al., 1999; Roque and Antony, 2010; Yarza et al., 2017; Zhang et al., 2017; Wijayawardene et al., 2020). There are six or eight distinct phyla of fungi, depending on the authors of the studies (Basidiomycota, Ascomycota, Glomeromycota, Blastocladiomycota, Chytridiomycota, and Neocallimastigomycota). Among the most recognized and accepted studies using molecular biology techniques are those of Hawksworth (2001a, 2001b), Hibbett et al., (2007), Kirk et al., (2008) Watkinson et al., (2016). The Ascomycota and the Basidiomycota have been resolved as sister taxa and they are called Dicaryomycota (the two parental haploid nuclei remain paired at first during sexual reproduction) whose spores are respectively produced in asci or at the tip of basidia (Bouchet et al., 2005; Taylor et al., 2015).

The knowledge of Algerian mushrooms is weakly documented. A small number of works are devoted to the description of the species listed and their biological activities, while studies that report on their trophic status are rare. The forests of Tlemcen have a diverse and rich fungal flora, but it has received little attention. The purpose of this study is to research possible new species not recorded throughout Algeria, which covers an area of 2.381.741 square kilometers, as well as to investigate the diversity of wild higher fungi and obtain a basic knowledge of their richness in representative natural biotopes of the research area, and also to determine their ecological status and identify them in order to contribute to the inventory of macro-fungi in the study region and also at the Algerian scale.

Materials and Methods

Study area

The study area is located in the North-West of Algeria, in the wilaya of Tlemcen, covering an area of 9,017.69 square kilometers and having 120 kilometers of coastline. The chief town of the wilaya is located 432 km west of the capital, Algiers. It is bordered by the Mediterranean Sea to the north, the Wilaya of Naama to the south, the Wilaya of Ain Temouchent to the east, the Wilaya of Sidi Bel

Abbes to the southeast, and finally Morocco to the west. It has a Mediterranean (semi-arid) climate. The highest temperatures are recorded in the summer, during dry periods with low rainfall. In the summer, the temperature can reach 45°C. In winter, it can drop below 0°C. The rainfall Emberger index is 51.1 (Ghalem et al., 2016). Mycological surveys were conducted from the autumn of 2018 to the spring of 2022, generally after rainfall periods. The 15 study sites are summarized in (Table 1) and illustrated in (Fig. 1).

Sampling sites

Fifteen sampling sites were selected in the study area for harvesting and collection. The selected sites were known to be the usual fruiting zones of the macro-fungi. This choice was based on the advice of local inhabitants and on the proximity of the host plants. Based on targeted sampling, stations that looked to be homogenous and representative were chosen.

Table 1. Designation of study localities in the wilaya of Tlemcen (North-West of Algeria).

N°	Localities	Abbreviations	Latitude	Longitude	Elevation (m)
1	Tlemcen	T.L	34°51’58’’	01°28’02’’	814
2	Ghazaouet	G.Z	34°04’48’’	01°50’49’’	74
3	Hafir and Zariffet	H.Z	34°47’52’’	01°26’14’’	904
4	Terny Beni Hdiel	T.B.H	34°46’38’’	01°20’39’’	1328
5	Lalla Setti	L.S	34°52’00’’	01°17’52’’	1098
6	Dar Yaghmouracene	D.Y	35°07’18’’	1°34’23’’	368
7	Souahlia	S.H	35°04’11’’	1°43’39’’	209
8	Nedroma	N.D	35°03’04’’	01°43’11’’	321
9	Bouhlou	B.H	34°50’06’’	01°30’05’’	292
10	Honaïne	H.N	35°09’09’’	01°4’35’’	392
11	Aïn Kebira	A.K	35°02’33’’	01°42’28’’	538
12	Beni Ouarsous	B.O	35°05’42’’	01°37’15’’	490
13	Beni Snous	B.S	34°37’50’’	01°34’35’’	875
14	Souk Tlata	S.T	35°02’35’’	01°58’09’’	342
15	El Aricha	E.A	34°27’52’’	01°11’50’’	1114

Morphological study

Macroscopic study

The identification was based on the macro and microscopic features of the fresh fruit bodies. To distinguish the collected mushrooms, photos have been taken and description sheets with determination keys have been filled in with the greatest care. Morphological recognition was performed by examining the different parts of the collected specimens, in particular: the cap, the hymenium, the stem, the flesh, the habitat, and others, according to the case of the mushrooms.

Microscopic study

For a better identification process, basidiospores and ascospores were removed and mounted in Melzer’s reagent. The observation of the spores was done by a binocular microscope equipped with a camera. Their dimensions were measured using the software Piximeter *(http://ach.log.free.fr/Piximetre/Telecharge.htm*). The identification operation is established by comparing the results of the observations with the determination keys of each character, referring to the following mycological guides: Tiévant, (2001); Bon, (2004); Roux, (2006); Chaumeton, (2008); Gerhardt, (2008); Whelan, (2011); Courtecuisse and Duhem, (2013); Lamaison and Polese, (2013); Redeuilh et al., (2015); Brodo, (2016); Eyssartier and Pierre, (2017); Roux et al., (2017); McNeil, (2019); Polese, (2019); Burgaz et al., (2020); Allen and Lendemer, (2021).

The period between the harvest and the identification must be as short as possible to avoid any possible changes or degradation of any characters. The nomenclatural names and taxonomic attributions of all taxa reported in this paper were checked against the Index Fungorum database (current name: http://www.speciesfungorum.org and position in classification: http://www.indexfungorum.org) or MycoBankdatabase (https://www.mycobank.org).

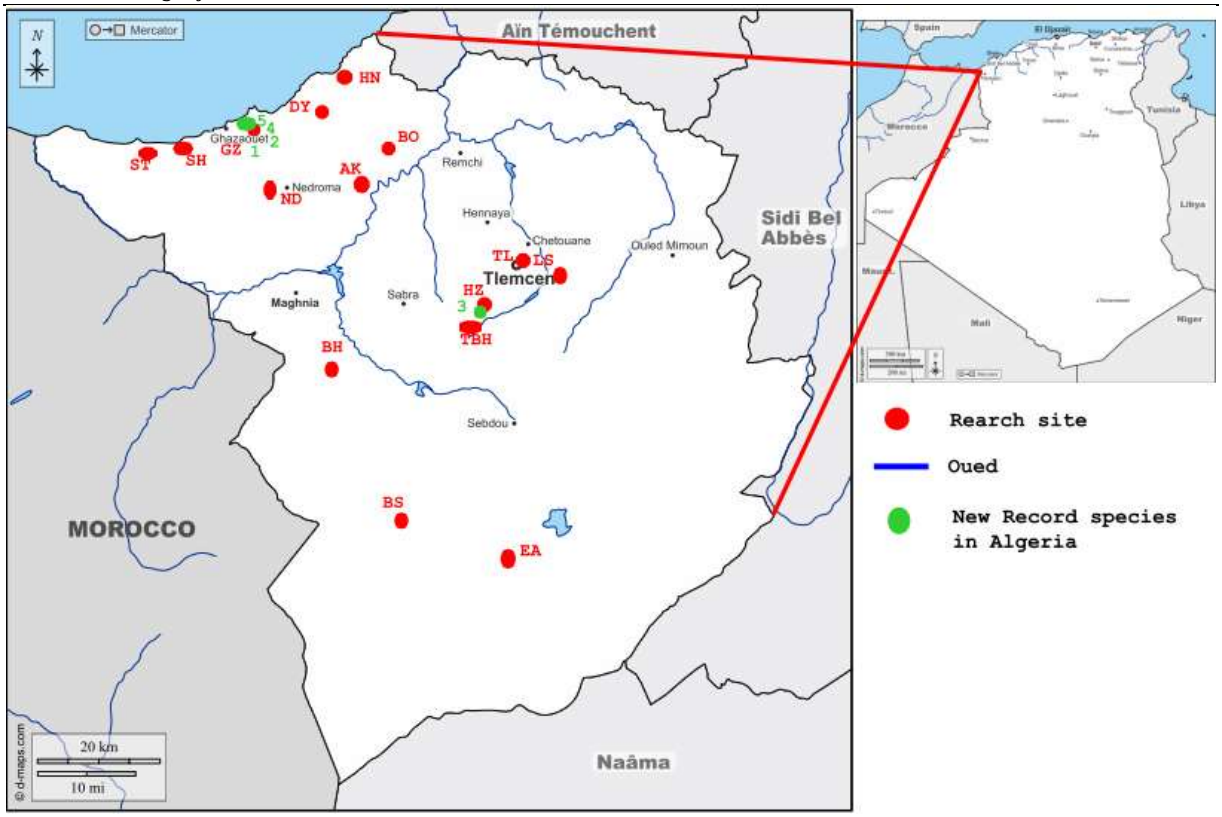

Figure 1. Map of the collection sites and the location of the five new species in Algeria.
1. Hygrophorus piceae; 2. Agaricus subperonatus; 3. Cortinarius speciosissimus; 4. Galerina camerina; 5. Stropharia melanosperma.

Results

This paper presents the first systematic checklist of 54 fungal species of Tlemcen. The details are provided in (Table 2). The difference between the species number of basidiomycetes and ascomycetes is important. Basidiomycetes dominate (Table 3). The fact that, in most cases, the carpophores of the ascomycetes are small in size makes them difficult to spot and observe (Kirk et al., 2008). During our surveys, we counted edible species, some of them have therapeutic properties, and others are toxic or even deadly. We noted a majority of saprophytic species (57,4%), followed by symbiotic species (mycorrhizal and lichen association) (35,2%) and a small percentage of parasitic species (7,4%) (Fig. 3).

During the study period, the surveys were carried out on the fifteen sites, and after the review of the scientific literature, five species were recorded for the first time in Algeria (Fig. 1). They are: *Agaricus subperonatus* (J.E. Lange) Singer. (1951) (Fig. 6A) and (Fig. 6B); *Cortinarius rubellus* Cooke, (1887) (Fig. 6C) and (Fig. 6D); *Galerina camerina* (Fr.) Kühner, (1955) (Fig. 6E) and (Fig. 6F); *Hygrophorus piceae* Kühner, (1949) (Fig. GA); and *Stropharia melanosperma* (Bull.) Gillet, (1878) (Fig. 6H). These species have never been reported in Algeria.

Table 2. List of mushrooms reported from Tlemcen (North-West of Algeria) with registration of new records.

Orders (Short description of Order)				
Families, Genus (Short description of Genus)	**Localities (In this study)**	**Synonyms**	**Localities in references**	**References (previous researches)**
Current names				
Sources of identification				
Boletales: Species with tubes and a central stipe. In adults, the fertile part (tube, some have gills) is easily separable from the cap.				
Boletaceae, Boletus: The cap is very fleshy, not slimy. The stipe is very wide with a network punctuated by red. The pores are very small.				
Suillellus luridus (Schaeff.) Murrill, (1909)	G.Z D.Y	*Boletus luridus* Sch.: Fr.	Tellian Atlas (Chréa)	(Lanier, 1994) in (Nezzar-Hocine et al., 1998)
		Boletus luridus J. C. Sch.: Fr.	North Africa	(Courtecuisse and Duhem, 2013)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2008; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Polese, 2019).			
Rubroboletus satanas (Lenz) Kuan Zhao & Zhu L. Yang 2014	G.Z D.Y	*Boletus satanas* Lenz	Algeria	(Courtecuisse and Duhem, 2013)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Polese, 2019).			
Suillaceae, granulatus Suillus: Species strictly related to conifers, slimy cap (when moist, the cap cuticle becomes sticky), tubular hymenium.				
Suillus granulatus (L.) Roussel, (1796)	G.Z N.D S.T L.S T.L H.N	*Boletus granulatus* Fr	Forest between Réghaïa and Alma (currently Boudouaou)	(Maire, 1927)
		Boletus granulatus Fr	Coastal forests, Blidean Atlas	(Dorleans, 1972)
		Suillus granulatus (L.) Roussel	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
Sources of identification	(Bon, 2004; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Polese, 2019).			
Suillus mediterraneensis (Jacquet. & J. Blum) Redeuilh, (1992)	GZ D.Y H.N S.T	*Suillus mediterraneensis*	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
Sources of identification	(Gerhardt, 2008; Courtecuisse and Duhem, 2013; Eyssartier and Pierre, 2017).			
Suillus collinitus (Fr.) Kuntze, (1898)	G.Z N.D S.T L.S H.N S.H	*Boletuscollinitus*	Tellian Atlas (Chréa)	(Lanier, 1994 in Nezzar-Hocine et al., 1998)
		Suillus collinitus	Forest of M'Sila (wilaya of Oran)	(Benazza-Bouregba, 2017)
		Suillus collinitus (Fr.) Kuntze	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)

Sources of identification	(Bon, 2004; Roux, 2006; Courtecuisse and Duhem, 2013; Polese, 2019).			
Suillus bovinus (L.) Roussel, (1796)	B.H	*Suillus bovinus*	North Africa	(Courtecuisse and Duhem, 2013)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017).			
Paxillaceae, Melanogaster: The tuberous fruiting bodies are yellowish ochre to extremely dark red brown in color, less elongated and more irregular. Mucilaginous black gleba and logettes containing the spores separated by whitish walls. They are entirely or partially immersed in the soil.				
Melanogaster broomeanus Berk (1843)	G.Z A.K D.Y	*Melanogaster variegatus* var. *Broomeianus* Tul.	Algeria	(Maire, 1930)
Sources of identification	(Arroyo et al., 2005; Eyssartier, 2018; Gminder, 2019).			
Agaricales: Fibrous flesh, little separable cap and stipe, attached gills (not free) decurrent or adnate, white or yellow, turn black at maturity (pink for agaric). Stipe and cap not separable. Absence of volva and ring (except some species of Armillaria).				
Tricholomataceae, Lepista: Fleshy species, gills sometimes separable.				
Lepista nuda (Bull.) Cooke, (1871)	G.Z H.Z T.B.H	*Rhodopaxillus nudus* (Bull.) Maire (1913)	Blidean Atlas and Teniet-el-Had	(Maire, 1914)
		Rhodopaxillus nudus	Cedar forest of Chréa (Blidean Atlas)	(Dorleans, 1972)
		Lepista nuda	Cork oak forest of Brabtia Mixed settlement of El Djer El Ouassaa	(Adoune, 2011)
		Lepista nuda	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Lepista nuda (Bull.: Fr.) Cooke	Boussouf (Constantine)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Lachaud et al., 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Polese, 2019 Phillips, 2021).			
Lepista sordida (Schumach.) Singer, (1951)	G.Z	*Lepista sordida (Schumach.)* Singer, (1951)	Forest of M'Sila (wilaya of Oran)	(Benazza-Bouregba, 2017)
		Lepista sordida (Schum.: Fr.) Singer	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017).			
Tricholomataceae, Tricholoma: Terricolous, fleshy, quite robust.				
Tricholoma pseudonictitans Bon, (1983)	L.S	*Tricholoma pseudonictitans* Bon	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
Sources of identification	(Roux, 2006; Chaumeton, 2010; Bon, 2004; Courtecuisse and Duhem, 2013; Eyssartier and Pierre, 2017; Lamaison and Polese, 2013).			
Tricholoma terreum (Schaeff.) P. Kumm., (1871)	G.Z B.O	*Tricholoma terreum*	Cedar forest of Chréa (Atlas blidéen)	(Dorleans, 1972)
		Tricholoma terreum (J.C. Sch.: Fr.) Kummer	Djurdjura Massif	(Nezzar-Hocine et al., 1996)

		Tricholoma terreum (J.C. Sch.: Fr.) Kummer	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017).			
Tricholoma portentosum (Fr.) (1873)	G.Z	*Tricholoma portentosum*	Blida	(Maire, 1914)
		Tricholoma portentosum (Fr.) Quél.	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
Sources of identification	(Bon, 2004; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Comandini et al., 2006; Phillips, 2021).			
Tricholomataceae, Clitocybe: Often infundibuliform, decurrent and fine gills, more or less fleshy.				
Clitocybe vibecina (Fr.) Quél. (1872)	H.Z T.B.H	*Clitocybe vibecina* (Fr.: Fr.) Quelet	North Africa	(Courtecuisse and Duhem, 2013)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Eyssartier and Pierre, 2017).			
Clitocybe odora (Bull.) P. Kumm., (1871)	H.Z T.B.H B.S	*Clitocybe odora*	Blida	(Maire, 1914)
		Clitocybe odora (Bull: Fr.) Kumm.	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Polese, 2019; Phillips, 2021).			
Tricholomataceae, Collybia: Cartilaginous or elastic flesh, flattened cap with adnate gills.				
Collybia tuberosa (Bull.) P. Kumm., (1871)	G.Z	*Microcollybia tuberosa* (Bull.:Fr)	North Africa	(Courtecuisse and Duhem, 2013)
Sources of identification	(Bon, 2004; Roux, 2006; Courtecuisse and Duhem, 2013; Gerhardt, 2008; Phillips, 2021).			
Pleurotaceae, Pleurotus, Pleurotacées (Family), null stipe, lateral or eccentric, growing on wood. except *P. eryngii*.				
Pleurotus ostreatus (Jacq.) P. Kumm., (1871)	B.S T.B.H	*Agaricus ostreatus*	Algeria	(Saccardo and Roumeguère, 1885)
		Pleurotus ostreatus (Jacq.)	Alma (currently Boudouaou)	(Patouillard, 1897)
		Pleurotus ostreatus (Fr.) Quél.	Forest between Réghaïa and Alma (currently Boudouaou)	(Maire, 1927)
		Pleurotus ostreatus (Jacq.: Fr.) Kummer	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Pleurotus ostreatus (Jacq.) P. Kumm.	Subareas of Darguina (wilaya of Bejaia) and Botanical Garden of El Hamma (Algiers)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Courtecuisse and Duhem, 2013; Lachaud et al., 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Phillips, 2021).			
Pleurotus cornucopiae (Paulet) Quél., (1885)	B.S H.Z T.B.H	*Pleurotus cornucopiae*	North Africa	(Courtecuisse and Duhem, 2013)

Sources of identification	(Bon, 2004; Roux, 2006; Chaumeton, 2010; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Lachaud et al., 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Polese, 2019).			
Pleurotus eryngii var. *ferulae* (Lanzi) Sacc., (1887) Current Name: *Pleurotus eryngii* (DC.) Quél. (1872)	G.Z B.H S.T D.Y B.O S.H	*Pleurotus fuscus* var. *ferulae* (Lanzi) Bres.	-On the stumps of Ferula longipes near Ain-Sefra -Sold on the market of Aïn-Sefra	(Maire, 1906a)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Lachaud et al., 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Polese, 2019).			
Hygrophoraceae, Hygrocybe: Bright color, growing in the herb.				
Hygrocybe chlorophana (Fr.) Wünsche, (1877)	G.Z	*Hygrophorus chlorophanus* (Fr.) Fr.	Cedar forest of Chréa (Blidean Atlas)	(Dorleans, 1972)
		Hygrocybe chlorophana (Fr.) Wünsche	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Roux, 2006; Chaumeton, 2010; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Phillips, 2021).			
Hygrophoraceae, Hygrophorus: Moist or viscous cap, thick, spaced gills with beeswax consistency. Bright color, growing in the herb.				
Hygrophorus piceae Kühner, (1949)	G.Z	**New record for Algeria**		
Sources of identification	(Bon, 2004; Roux, 2006; Eyssartier and Pierre, 2017).			
Mycenaceae, Mycena: Medium, little fleshy, not putrescible with thin and coriaceous stipe.				
Mycena acicula (Schaeff.) P. Kumm., (1871)	G.Z	*Mycena acicula*	Algeria	(Maire and Werner, 1937)
Sources of identification	(Bon, 2004; Roux, 2006; Courtecuisse and Duhem, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Phillips, 2021).			
Marasmiaceae, Marasmius: Medium, little fleshy, not putrescible with thin and coriaceous stipe.				
Marasmius collinus (Scop.) Singer, (1942)	H.Z N.D	*Marasmius collinus*	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
Sources of identification	(Bon, 2004; Chaumeton, 2010; Eyssartier and Pierre, 2017).			
Psathyrellaceae, Psathyrella: Campanulate or flattened cap (not striated), brown-black gills at maturity.				
Psathyrella marcescibilis (Britzelm.) Singer, (1951)	G.Z	*Psathyrella marcescibilis*	North Africa	(Courtecuisse and Duhem, 2013)
Sources of identification	(Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Eyssartier and Pierre, 2017).			
Psathyrellaceae, Coprinellus: Species and varieties of *Coprinellus* sp: genetic investigations revealed that around sixty species from the genus *Coprinus* sp are redistributed in the *Coprinellus* sp. *Coprinellus xanthothrix*: sugar-like flakes sprinkled with chocolate.				
Coprinellus saccharinus (Romagn.) P. Roux, Guy García & Dumas, (2006)	H.Z G.Z	*Coprinellus saccharinus*	Subareas of Darguina (wilaya of Bejaia) and Botanical Garden of El Hamma (Algiers)	(Youcef Khodja, 2021)

Sources of identification	(Roux, 2006; Eyssartier and Pierre, 2017).			
Coprinellus xanthothrix (Romagnesi) Vilgalys, Hopple & Jacq. Johnson (2001)	H.Z G.Z	*Coprinus xanthothrix* Romagn.(1941)	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Roux, 2006; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Eyssartier and Pierre, 2017).			
Psathyrellaceae, Coprinus: Flesh thin and fragile, cap ovoid or conical or flattened or striated. Stipe separable from the cap, gills turning black when ripe.				
Coprinus comatus (O.F. Müll.) Pers., (1797)	H.Z	*Coprinus ovatus* (Schœff.) Fr. Epicr *Agaricus ovatus* Schaeff.	Near Terni (Tlemcen)	(Maire, 1906a)
		Coprinus comatus (Müll.: Fr.) Pers.	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
		Coprinus comatus (Müll.: Fr) Pers.	Mixed settlement of El Djer El Ouassaa	(Adoune, 2011)
		Coprinus comatus (O.F. Müll.: Fr.) Pers.	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Coprinus comatus	Belezma National Park	(Boukerker and Boumedjane, 2018)
		Coprinus comatus (O.F. Müll.) Pers.	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Polese, 2019; Phillips, 2021).			
Psathyrellaceae, Panaeolina: Brown hay mushroom or mower's mushroom, pinkish-brown with a convex to conical cap and adnexed gills, also found on lawns.				
Panaeolina foenisecii (Pers.) Maire, (1933)	G.Z D.Y	*Panaeolina foenisecii*	Algeria	(Malencon and Bertault, 1970) in (Keddad and Bouznad, 2019)
		Panaeolus foenisecii Fr. (Pers.) Schröt.	National Park of Chréa	(Youcef Khodja, 2010)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017).			
Agaricaceae, Agaricus: Stipe and cap separable, gills pink then brown-black with membranous ring.				
Agaricus bitorquis (Quél.) Sacc., 1887	G.Z D.Y B.O	*Agaricus bitorquis* (Quél.) Sacc.	Hypogeous or semi-epigeous, near Khreider, in Sidi-Khalifa.	(Maire, 1906a)
		Agaricus bitorquis (Quél.) Sacc.	Botanical Garden of El Hamma (Algiers)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Phillips, 2021).			
Agaricus campestris L. (1753)	G.Z D.Y A.K	*Agaricus campestris*	Algerian Oasis	(Maire, 1906a)
		Agaricus campester Fr.	Forest between Réghaïa and Alma (currently Boudouaou)	(Maire, 1927)

		Agaricus campestris L.: Fr.	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Agaricus campestris L.	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019; Phillips, 2021).			
Agaricus subperonatus (J.E. Lange) Singer, (1951)	G.Z	**New record for Algeria**		
Sources of identification	(Bon, 2004; Gerhardt, 2008; Courtecuisse and Duhem, 2013).			
Amanitaceae, Amanita: Subgenus: Amanita: amanite with a ring on the stipe with a well or little developed volva. Subgenus: Amanitopsis: without ring on the stipe.				
Amanita vaginata (Bull.) Lam., (1783)	N.D	*Amanita vaginata* (Bull.: Fr.) Vitt.	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
		Amanita vaginata (Bull. :Fr.) Quél.	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Eyssartier and Pierre, 2017; Polese, 2019; Phillips, 2021).			
Entolomataceae, Entoloma: Cap and stem not separable, gills not decurrent, glabrous or slightly fibrous.				
Entoloma rhodopolium (Fr.) P. Kumm., (1871)	L.S H.Z	*Entoloma rhodopolium* (Fr.)	Cedar forest of Chréa (Atlas Blidéen)	(Dorleans, 1972)
		Entoloma rhodopolium (Fr.) P. Kumm.	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017).			
Lycoperdaceae, Vascellum: Puffball mushroom, Carpophore warty to smooth and piriform. A diaphragm that separates the gleba from the subgleba, a large apical opening gives the appearance of an urn. Mass of spores inside, escape when an opening is torn.				
Lycoperdon pratense Pers. (1794)	A.K N.D	*Lycoperdon hiemale* Bull.	Coastal dunes, La Calle (currently El Kala)	(Bory de Saint-Vincent and Durieu de Maisonneuve, 1846)
		Vascellum pratense (Pers.) Krei.	Mixed settlement of El Djer El Ouassaa	(Adoune, 2011)
Sources of identification	(Bon, 2004; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Eyssartier and Pierre, 2017).			
Lycoperdaceae, Bovista: Globular or pear-shaped, known as earth balls, inside becoming powdery when ripe.				
Bovista plumbea Pers., (1795)	G.Z	*Bovista plumbea Pers.*	The surroundings of Algiers	(Montagne, 1838)
		Lycoperdon plumbeum Vittad.	Algeria	(Saccardo and Roumeguère, 1885)
		Bovista plumbea	Blida	(Maire, 1914)
		Bovista plumbea Pers.: Pers.	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
		Bovista plumbea Pers.: Pers.	National Park of Chréa	(Youcef Khodja, 2010)
		Bovista plumbea Pers.: Pers.	National Park of El Kala (North East	(Djelloul, 2014)

		Algeria)		
Sources of identification	(Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; (Eyssartier and Pierre, 2017).			
Strophariaceae, Stropharia: Presence of a ring or flakes on the stipe, dark purplish brown gills at maturity.				
Stropharia melanosperma (Bull.) Gillet, (1878)	G.Z	**New record for Algeria**		
Sources of identification	(Courtecuisse and Duhem, 2013).			
Strophariaceae, Agrocybe: Wrinkled cap, presence of the ring, gills with tobacco brown color at maturity.				
Agrocybe molesta (Lasch) Singer (1940)	G.Z T.L	*Pholiota dura* (Fr.) Quel.	Forest between Réghaïa and Alma (currently Boudouaou)	(Maire, 1927)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Eyssartier and Pierre, 2017; Phillips, 2021).			
Agrocybe praecox (Pers.) Fayod, (1889)	G.Z N.D T.L	*Agaricus praecox* Pers., *Pholiota praecox* (Pers.) Krast.	Forests of Quercus suber towards Hafir, on sandstone (Tlemcen)	(Maire, 1906a)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Eyssartier and Pierre, 2017; Phillips, 2021).			
Cortinariaceae, Cortinarius: Presence of a cortina, gills tinged with rust at maturity.				
Cortinarius speciosissimus Kühner & Romagn., (1953) current name: *Cortinarius rubellus* Cooke (1887)	H.Z	**New record for Algeria**		
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; Gminder, 2019).			
Hymenogastraceae, Gymnopilus: Grows on wood, rusty ochre blade.				
Gymnopilus junonius (Fr.) (1960)	G.Z	*Gymnopilus spectabilis* (Fr.) P.D. Orton	National Park of Chréa	(Youcef Khodja, 2010)
		Gymnopilus spectabilis	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Gymnopilus spectabilis	Forest of M'Sila (wilaya of Oran)	(Benazza-Bouregba, 2017)
Sources of identification	(Bon, 2004; Knudsen and Petersen, 2005; Roux, 2006; Chaumeton, 2010; Gerhardt, 2008; Courtecuisse and Duhem, 2013; Lamaison and Polese, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017).			
Hymenogastraceae, Galerina: Small mushroom, convex or campanulate cap, rusty ochre gills.				
Galerina camerina (Fr.) Kühner, (1955)	G.Z	**New record for Algeria**		
Sources of identification	(Roux, 2006; Lamaison and Polese, 2013; Eyssartier and Pierre, 2017).			
Pluteaceae, Volvopluteus: Ample volva, separable cap and stipe.				
Volvopluteus gloiocephalus	G.Z	*Volvaria speciosa* (Fr.) P.	Tell and in the vicinity of Algiers	(Maire, 1916)

(DC.) Vizzini, Contu & Justo, (2011)	T.L	Kumm.		
		Volvariella gloiocephala	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Volvopluteus gloiocephalus (DC.)	Forest of M'Sila (wilaya of Oran)	(Benazza-Bouregba, 2017)
		Volvopluteus gloiocephalus (DC.) Vizzini, Contu & Justo	Botanical Garden of El Hamma (Algiers)	(Youcef Khodja, 2021)
Sources of identification	(Roux, 2006; Courtecuisse and Duhem, 2013; Redeuilh et al., 2015; Eyssartier and Pierre, 2017; (Polese, 2019).			
Russulales: with brittle flesh like chalk (non-fibrous)				
Russulaceae, Russula: Straight cylindrical stipe, gills of equal length or forked, no milk flows at breakage.				
Russula delica Fries (1838)	H.Z B.S	*Russula delica* Fr.	Forest between Réghaïa and Alma (currently Boudouaou)	(Maire, 1927)
		Russula delica Fr.	Djurdjura Massif	(Nezzar-Hocine et al., 1996)
		Russula delica	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Russula delica Fr.	Mixed settlement of El Djer El Ouassaa	(Adoune, 2011)
Sources of identification	(Bon, 2004) (Knudsen and Petersen, 2005) (Roux, 2006) (Chaumeton, 2010) (Gerhardt, 2008) (Redeuilh et al., 2015) (Courtecuisse and Duhem, 2013) (Eyssartier and Pierre, 2017).			
Auriculariales: Transversely septate basidia, saprophytic, mostly on dead wood.				
Auriculariaceae, Auricullaria: Fruitbody resupinates, becoming pile-shaped and then ear-shaped, gelatinous tough or elastic, often purplish, growing on wood.				
Auricularia auricula-judae (Bull.) Quél., (1886)	H.Z	*Auricularia auricula-Judae* Berk	Bône (currently Annaba) and Alma (currently Boudouaou, wilaya of Boumerdes)	(Patouillard, 1897)
		Auricularia auricula-judae (Fr.) Berk.	Forest between Réghaïaand Alma (currently Boudouaou)	(Maire, 1927)
		Auricularia auricular-judae (Bull.: Fr.) Wettst	National Park of El Kala (North East Algeria)	(Djelloul et al., 2010)
		Auricularia auricula-judae	National Park of El Kala (North East Algeria)	(Djelloul, 2014)
		Auricularia auricula- judae (Bull.) Quél	Babors mountain (northeastern Algeria)	(Youcef Khodja et al., 2020)
		Auricularia auricula-judae (Bull.) J. Schröt.	Subareas of Darguina (wilaya of Bejaia) and Botanical Garden of El Hamma (Algiers)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004) (Knudsen and Petersen, 2005) (Roux, 2006) (Gerhardt, 2008) (Courtecuisse and Duhem, 2013) (Lamaison and Polese, 2013) (Redeuilh et al., 2015) (Eyssartier and Pierre, 2017) (Gminder, 2019) (Polese, 2019) (Phillips, 2021).			
Hymenochaetales: Fruit bodies that are brown, (become black when exposed to alkali), thorn-shaped cystidia.				
Hymenochaetaceae, Inonotus: Bristly polypore, in console, thick.				
Inonotus hispidus (Bull.) P.	H.Z T.L	*Xantochrous tinctorius* Quélet	Wilaya of Ouargla	(Patouillard, 1897)

Karst., (1879)		*Xantochrous hispidus Fr.*	Algiers and Bône (currently wilaya of Annaba)	
Sources of identification	(Bon, 2004) (Gerhardt, 2008) (Courtecuisse and Duhem, 2013) (Redeuilh et al., 2015).			
Hymenochaetaceae, Phellinus: Multi-year carpophore, Console or null cap, woody.				
Phellinus pomaceus (Pers.) Maire, (1933)	H.Z	*Phellinus tuberculosus* (Baumg.) Niemelä	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Knudsen and Petersen, 2005)			
Polyporales: Pores under the cap, presence or not of stipe, produce large Fruitbody found on the wood.				
Polyporaceae, Trametes: On the wood, coriaceous and thin, upper side decorated with concentric circles.				
Trametes versicolor (L.) Lloyd, (1921)	H.Z	*Coriolus versicolor*	Blida	(Maire, 1914)
		Coriolus versicolor (Fr.) Pat.	Forest between Réghaïa and Alma (currently Boudouaou)	(Maire, 1927)
		Trametes versicolor	Belezma National Park	(Boukerker and Boumedjane, 2018)
		Trametes versicolor (L.) Lloyd	Babors mountain (northeastern Algeria)	(Youcef Khodja et al., 2020)
		Trametes versicolor (L.) Lloyd	Subareas of Darguina (wilaya of Bejaia)	(Youcef Khodja, 2021)
Sources of identification	(Bon, 2004) (Knudsen and Petersen, 2005) (Chaumeton, 2010) (Gerhardt, 2008) (Courtecuisse and Duhem, 2013) (Lamaison and Polese, 2013) (Redeuilh et al., 2015) (Eyssartier and Pierre, 2017) (Polese, 2019).			
Gloeophyllales: Wood decaying fungi, produce the brown rot of wood.				
Gloeophyllaceae, Gloeophyllum: United as wood gill polypores, leathery to corky flesh, tubes often labyrinthine to lamellar, spores not amyloid and without pg.				
Gloeophyllum abietinum (Bull.) P. Karst., (1882)	G.Z	*Lenzites abietinus* (Bull.) Fr.	Forests of the Aures (in Sgag, currently Tazoult)	(Patouillard, 1903)
		Gloeophyllum abietinum (Bull. : Fr.) P. Karsten	Subareas of Darguina (wilaya of Bejaia	(Youcef Khodja, 2021)
Sources of identification	(Schmidt, 2006) (Gerhardt, 2008) (Redeuilh et al., 2015).			
Pezizales: Characterized by asci, spread out, looking like a big pleated pezize, (Truffles: more or less globular growing underground).				
Helvellaceae, Helvella: Very irregular cap, calyx shape with crenelated border.				
Dissingia leucomelaena (Pers.) K. Hansen & X.H. Wang, (2019)	H.Z	*Helvella leucomelaena* (Pers.)	North Africa	(Courtecuisse and Duhem, 2013)
Sources of identification	(Bon, 2004) (Chaumeton, 2010) (Gerhardt, 2008) (Courtecuisse and Duhem, 2013) (Lamaison and Polese, 2013) (Redeuilh et al., 2015).			
Pezizaceae, Peziza: Exclusively spring, spread out, and resemble a large pezize, in section becoming irregularly shaped.				
Peziza vesiculosa Bull., (1790)	G.Z	*Peziza vesiculosa* Bull.	Bône (currently Annaba)	(Steinheil, 1834)
	H.Z T.B.H	*Peziza vesiculosa*	Cedar forest of Chréa(Atlas Blidéen)	(Dorleans, 1972)
Sources of identification	(Chaumeton, 2010) (Gerhardt, 2008) (Courtecuisse and Duhem, 2013) (Lamaison and Polese, 2013) (Redeuilh et al., 2015), (Eyssartier and Pierre, 2017) (Phillips, 2021).			
Pezizaceae, Terfezia: Salmon color, under *Helianthemum* spp.				

Terfezia claveryi Chatin, (1892)	E.A	*Terfezia claveryi* Chatin	Aïn-Sefra (sold in quantity on the market), Ben-Zireg, Naâma (sandy-clay steppes). The Khreider, in Sidi-Khalifa (sandy-clay steppes).	(Maire, 1906a)
		Terfezia claveryi Chatin	Oasis of Laghouat	(Malençon, 1973)
		Terfezia claveryi Chatin	El Aricha, Ain Safra, Biskra, Bou Saada, Chellala, Colomb Bechar, Constantine, Laghouat, Oued Rhiou, Sidi Khalifa.	(Alsheikh, 1994)
		Terfezia claveryi Chatin	Ghardaia and Ouargla (Northern Sahara of Algeria)	(Bradai et al., 2014)
		Terfezia claveryi	Stidia and Ksar Chellala (semiarid areas of Algeria)	(Zitouni-Haouar et al., 2014)
		Terfezia claveryi	Chelala El-Bayadh	(Boufeldja et al., 2016)
		Terfezia claveryi	local markets in Tiaret (Algeria)	(Neggaz et al., 2015)
Sources of identification	(Arroyo et al., 2005) (Eyssartier, 2018) (Gminder, 2019).			
Lichenes, Lecanorales: Enormous order containing about 6000 species, the majority of the lichenized species belonging to this order.				
Cladoniaceae, Cladonia: Most species of the family Cladoniaceae belong to this genus. The majority, they are terricolous, but several live on wood.				
Cladonia mediterranea P.A. Duvign. & Abbayes, (1947)	G.Z D.Y	*Cladonia mediterranea* Duvign et Des Abb.	Algeria	(Faurel et al., 1951)
		Cladonia mediterranea P.A.Duvign. & Abbayes	Algeria	(Burgaz et al., 2020)
Sources of identification	(Roux et al., 2017) (Burgaz et al., 2020).			
Ramalinaceae, Ramalina: Mainly corticolous, also frequent saxicolous, shrubby, often tufted. The asci are elongate-clavate, 8-spored.				
Ramalina lacera (With.) J.R. Laundon, (1984)	G.Z D.Y	*Ramalina evernioides* Nyl.	Near Algiers	(Flagey, 1896)
		Ramalina lacera (With.) Laundon	Coast of Oran	(Bendaikha and Hadjadj-Aoul, 2016)
Sources of identification	(Whelan, 2011) (Roux et al., 2017) (Cannon et al., 2021).			
Teloschistales: The ascomata are apothecia, the asci are apical, the tholus is present, the spores are often hyaline, anthraquinoid pigments always present, on various substrates.				
Teloschistaceae, Xanthoria: Also called the orange lichen. Stratifying, tiny to small. They are foliose or sometimes fruticose, usually bearing scattered.				
Xanthoria parietina (L.) Th. Fr., (1860)	G.Z D.Y	*Parmelia parietina* (L.) Ach.	Bône (currently Annaba)	(Steinheil, 1834)
		Xanthoria parietina (L.) Th. Fr.	Oubeira Lake (National Park of El Kala)	(Serradj et al., 2013)
		Xanthoria parietina Th. Fr.	Oak forest of Bougous (National Park of El Kala)	(Slimani et al., 2013)
		Xanthoria parietina (L.) Th.Fr.	Coast of Oran	(Bendaikha and Hadjadj-Aoul, 2016)
		Xanthoria parietina (L.) Th. Fr.	Djurdjura National Park (Algeria)	(Chaker et al., 2021)
Sources of identification	(Tiévant, 2001) (Whelan, 2011) (Brodo, 2016) (Roux et al., 2017) (Allen and Lendemer, 2021).			
Myxomycota: **Trichiales,** Order of slime molds, is one of the five of the group Myxomycetes of the phylum Amibozoa, most are plasmodiocarps or sporangia, rarely pseudoethalia,				

capillary always present.				
Arcyriaceae, Arcyria,				
Arcyria oerstedii Rostaf., (1875)	G.Z	*Arcyria oerstedii* Rostaf.	Algeria	(Ndiritu et al., 2009)
Sources of identification	(McNeil, 2019).			

Discussion

Diversity and richness of the fungal species in Tlemcen

Fig. 2 shows the distribution of the fungal flora according to mycological phyla. 47 species (87%) belong to the phylum of Basidiomycota, 06 species (11%) to Ascomycota, and one species (2%) to Myxogastrea (a taxonomic class of the Amoebozoa phylum). The Basidiomycota phyla (Fig. 4) and (Fig. 5) are more diverse, with 7 orders.

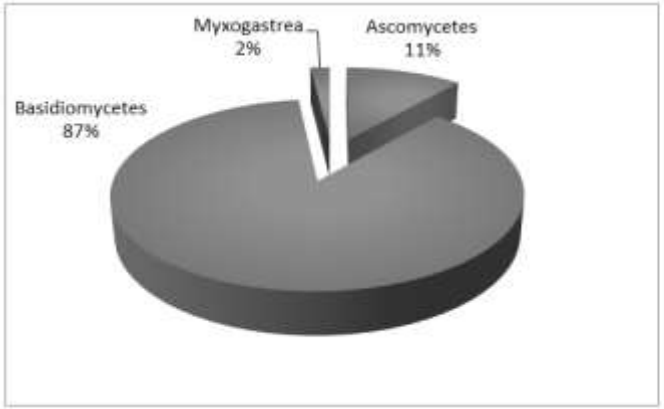

Figure 2. Distribution of the phyla of the collected mushrooms in Tlemcen.

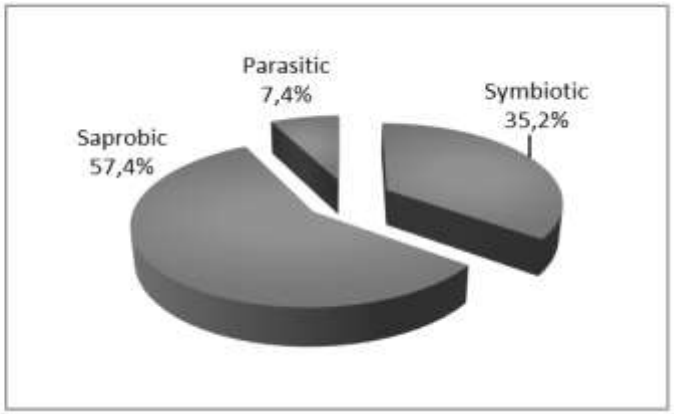

Figure 3. Trophic status of the collected mushrooms in Tlemcen

The richest species order found in the 15 stations is the Agaricales, with 34 species (63%), the Boletales, composed of 7 species (13%), and the Hymenochaetales with 2 species (3.7%), present in 10, 06, and 03 stations respectively. Russulales, Auriculariales, Polyporales, and Gloeophyllales (1.9%) for each of them, with a total of 04 species found in 03 stations.

The phyllum of Basidiomycota includes 22 families, arranged as follows: Tricholomataceae had 8 species (14.8%), Psathyrellaceae had 05 species (9.3%), Suillaceae had 04 species (7.4%), Pleurotaceae, Agaricaceae, and Strophariaceae had 03 species (5.6%) each, and Boletaceae, Hygrophoraceae, Lycoperdaceae, Hymenogastraceae, and Hymenochaetaceae had 02 species (3.7%) for each of them. Finally, Gloeophyllaceae, Polyporaceae, Auriculariaceae, Russulaceae, Pluteaceae, Cortinariaceae, Entolomataceae, Amanitaceae, Marasmiaceae, Mycenaceae, and Paxillaceae at the same value, one species (1.9%). The phyllum of Ascomycota (Fig. 4) and (Fig. 5) have a reduced value, with 03 orders (Pezizales, Lecanorales, and Teloschistales) composed of 05 families. Helvellaceae has two species (3.7%), while Pezizaceae, Cladoniaceae, Ramalinaceae, and Teloschistaceae each have one species (1.9%), with 06 species found in 04 stations.

Myxomycetes (Fig. 4) and (Fig. 5), this class with a single order Trichiales in this study, including a unique family Arcyriaceae with only one species, with a percentage that amounts to (1.9%) of this work, found in only one station.

The western African macro-fungal flora has been investigated by: De Kesel et al., we mention the works of Ndong et al., (2011) for Central Africa. We cite the research of Patouillard, (1905); Patouillard, (1906); Malençon, (1973); Haimed et al., (2013); Nounsi et al., (2014) as examples for North Africa. The studies carried out on the macro-fungal in Algeria, such as Bory de Saint-Vincent and Durieu de Maisonneuve, (1846). For the most recent mycological studies are: Dorleans, (1972); Keddad and Bouznad, (2019) about the Atlas cedar forest of Blida in the Chréa region, and Lanier, (1994) concerning the cedar forest of Djudjura, another study of Nezzar-Hocine et al., (1998) representing 48 different genera, and for the first time in Algeria, forty species of ectomycorrhizal fungi were observed. A preliminary inventory of *Russula* associated with cork oak in Algeria is proposed by: Chekireb et al., (2013) in the National Park of El-Kala. A study on the fungi of the cedar forests of the Belezma National Park allowed the inventory of 50 species of Basidiomycetes and 1 species of Ascomycetes (Boukerker and Boumedjane, 2018). In the Babors Kabylia (Northern Algeria), 110 species of Agaricomycetes, belonging to 72 genera, were identified according to a research by Youcef Khodja et al., (2020).

The environment of Tlemcen is characterized by the great diversity of the ecosystem and the Mediterranean climate, also characterized by an increasing aridity from the North to the South. The distribution of fungal species according to their trophic modes is influenced by the nature and age of the stand (Hawksworth and Mueller, 2005), as well as the Mediterranean climate, favorable for the fructification of macro-fungi (Ortega and Navarro, 2006) which shows a remarkable diversification of the mushrooms. Hypogeous species include *Melanogaster* in the littoral and *Terfezia* in arid climates, as well as mycorrhizae and lichens. Mycorrhizal fungi provide host plants with a better mineral intake, greater tolerance to abiotic stresses, and protection against certain pathogens (Chen et al., 2018; de Almeida et al., 2021). Fungal repartition is always influenced by biotic and abiotic factors. The symbiotic association between the two organisms, fungus and algae, allows the lichen to acquire new properties. They are very resistant to variations in environmental conditions (resistance to salinity, temperature variations, and resistance to desiccation caused by exposure to wind and sun). They are also able to retain large quantities of water. They are real bio-indicators, witnesses of the quality of a biotope. They are capable of decomposing wood and even eroding rocks. Its growth is very slow (Brodo, 2016; Spjut et al., 2020; Allen and Lendemer, 2021).

Myxogastrea or Myxomycetes, formerly considered as fungi, are nowadays classified separately. However, they are still studied by mycologists (Courtecuisse and Duhem, 2013; Eyssartier and Pierre, 2017; McNeil, 2019). Due to the limited mycological inventory in Tlemcen, we compared our results with the work done by Maire, (1906a) on the mushrooms of North Africa, regarding the forests of cork oak *Quercus suber* around the region of Tlemcen (Tirni, Hafir, and near Tlemcen).

Boletus tlemcenensis Maire, currently named *Leccinellum tlemcenense*, which was described by Maire, (1906b) and Maire, (1909) was not observed in this survey. *Melanogaster broomeanus* Berk (1843), collected in this study in 03 stations, was only indicated by Maire, (1930) without specifying the exact location of the harvest in Algeria. During our study, we found on the site of El-Aricha, the

famous truffle *T. claveryi*, known for its socio-economic and medicinal importance. Its presence in this area is already recorded by R. Maire in their work "Mushrooms of North Africa" (Alsheikh, 1994). The truffle and *Agaricus bitorquis*, mentioned in our study were already known as edible and consumed in large quantities according to Maire, (1906a). *A. campestris, P. ostreatus, S. granulatus* (under the name *B. granulatus*) were observed in Réghaïa by (Maire, 1927) and *A. campestris* was observed in Morocco (Maire and Werner, 1937). The variety *P. eryngii* var *ferulea* (Lanzi) which was collected in our study in the coastal site of Ghazaouet, was reported by Maire, (1906a) to be consumed and sold in the markets of Aïn-Sefra (wilaya of Naama), also *P. eryngii* (designated as *Pleurotus fuscus*) was mentioned in the same study as found on *Eryngium campestre* in the meadows of Terni (wilaya of Tlemcen). The same species was noted as edible and very abundant by Trabut, (1887). The genera *Coprinus* sp, *Cortinarius* sp, *Peziza* sp and *Lycoperdon* sp that are indicated in our study are also observed by (Maire, 1906a) in the different areas of Tlemcen.

Marasmius collinus, mentioned in the present study, considered as a toxic species, was recorded for the first time in Algeria (El Kala) by (Djelloul, 2014), *Coprinellus saccharinus* was reported in the Botanical Gardens of El Hamma (Algiers) and Darguina (Béjaia). *Phellinus tuberculosus* was observed in Darguina (Béjaia) (Youcef Khodja, 2021).

For the Myxomycetes, a species of the genus *Arcyria* (*A. incarnata*) was observed on rotten wood of *Quercus suber* towards the forest of Hafir (Tlemcen) by (Maire, 1906a), while in our study, *A. oerstedii* was found near the coastline in Ghazaouet. The three species of lichens observed in our study are mentioned in an update of the inventory of lichens in Algeria (Ait Hammou et al., 2014). In a diversity study of lichens in the Hafir forest, in the national park of Tlemcen, the presence of *X. parietina* was reported, while *C. mediterranea* and *R. lacera* were not mentioned (Maazouz et al., 2022), whereas, in a survey of lichen species harvested on the Oran coast, *X. parietina* and *R. lacera* were observed (Bendaikha and Hadjadj-Aoul, 2016). For the genus *Ramalina*, in the present work, we have observed *R. lacera* while two species *R. usneoides* and *R. pusilla*, were mentioned by (Bory de Saint-Vincent and Durieu de Maisonneuve, 1846).

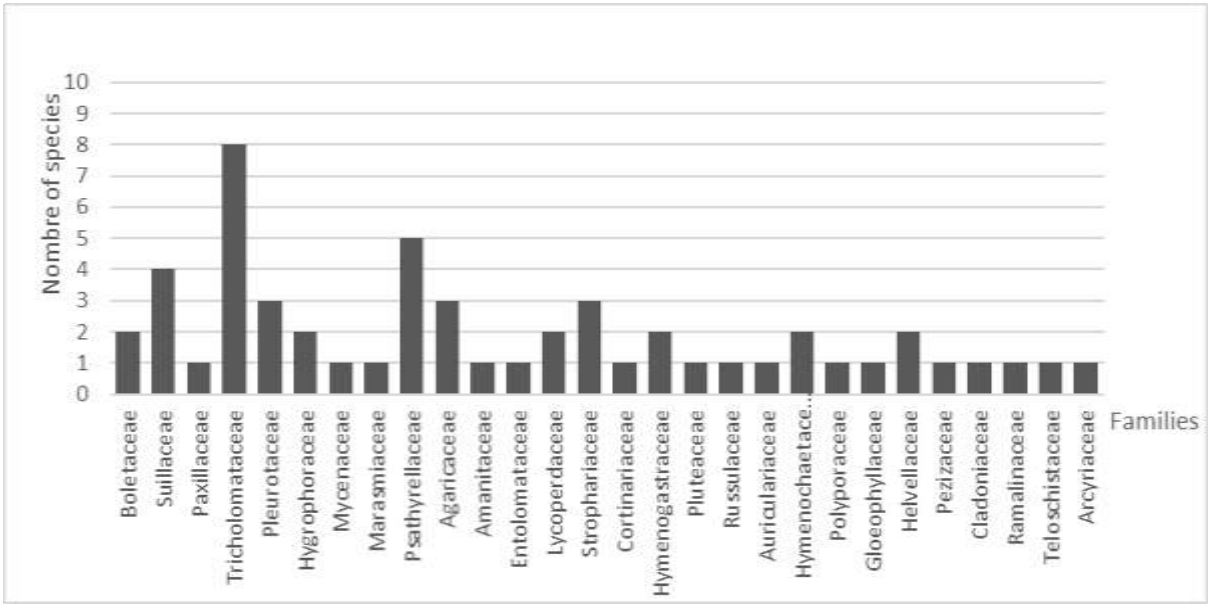

Figure 4. Distribution of the different families of the harvested mushrooms in Tlemcen.

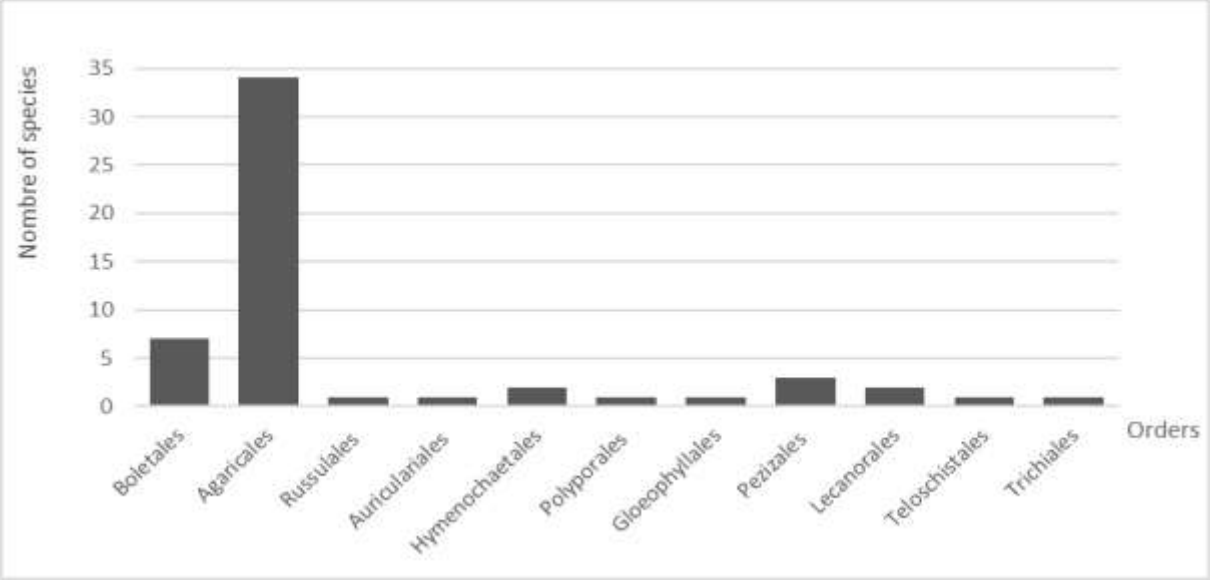

Figure 5. Distribution of the different orders of the collected mushrooms in Tlemcen.

Newly recorded data

Based on an intensive search of the literature, the results of this inventory are compared with the species mentioned in the catalog realized by Keddad and Bouznad, (2019), the first inventory in the form of a research work describing almost all written studies on the Algerian fungal flora since 1799 and consequently registering 2105 species. Thus, the studies conducted by: Dorleans, (1972); Nezzar-Hocine et al., (1998); Djelloul et al., (2010); Chekireb et al., (2013); Benazza-Bouregba et al., (2016) Ouali et al., (2016); Aouali et al., (2018); Boukerker and Boumedjane, (2018); Youcef Khodja et al., (2020); Benfriha et al., (2020); Aouali, (2021) and Mesfek et al., (2021) and the theses of: Adoune, (2011); Mesfek, (2014); Djelloul, (2014); Kadi-Bennane, (2016) Benazza-Bouregba, (2017) and Youcef Khodja, (2021) including the works of: Bory de Saint-Vincent and Durieu de Maisonneuve, (1846); Saccardo and Roumeguère, (1885); Patouillard, (1897); Patouillard, (1902); Patouillard, (1905); Maire, (1905); Maire, (1906a) ; Patouillard, (1906); Maire, (1914); Maire, (1927); Maire, (1928) and Maire, (1930). For lichens, it is mainly the works of: Werner, (1955); Ait Hammou et al., (2014); Amrani et al., (2015) and Amrani et al., (2018).

Table 3. Taxonomic distribution based on species identified in the Tlemcen region (North-West of Algeria).

Orders	Family number	Genera number	Species number	Percentage (%)
		Basidiomycota		
Boletales	3	3	7	13
Agaricales	14	24	34	63
Russulales	1	1	1	1,9
Auriculariales	1	1	1	1,9
Hymenochaetales	1	2	2	3,7
Polyporales	1	1	1	1,9
Gloeophyllales	1	1	1	1,9
		Ascomycota		
Pezizales	2	3	3	5,6
Lecanorales	2	2	2	3,7
Teloschistales	1	1	1	1,9
		Myxogastrea		
Trichiales	1	1	1	1,9
		Total		
11	**28**	**40**	**54**	**100**

The research in the previous studies was done with the actual scientific names as well as with their synonyms listed in the Index Fungorum database. Finally, following the steps of identification and comparison with the different recognized guides in this field and subsequent investigations of additional studies, we can conclude that we are dealing with 5 mushrooms newly recorded in Algeria through the current survey.

Figure 6. New records of mushrooms in Algeria, (A) (B) *Agaricus subperonatus*; (C) (D) *Cortinarius rubellus*; (E) (F) *Galerina camerina*; (G) *Hygrophorus piceae*; (H) *Stropharia melanosperma*.

Conclusion

The region of Tlemcen is very rich in fungal biodiversity, this diversity is mainly related to the parameters of the soil, the climate and the vegetation, from the coast to the steppe. Throughout the present survey, five species recorded for the first time, are newly added to the Algerian list of higher fungi. Also, 54 species were registered in the 15 plots of the study area, belonging to 40 genera, 28 families and 11 orders. In addition, we note 31 saprobic species, 19 symbiotic species, and four parasitic species. This list of mushrooms is considered provisional and should be updated regularly. Some species are appreciated for their culinary and gustatory qualities and some of them are considered as a source of healthy food. They contribute to high antioxidant and antimicrobial effects certain species are also known for their medicinal virtues, such as *T. claveryi*, *Pleurotus* spp., while others are extremely toxic or even deadly, such as *R. satanas* and the two species newly recorded in Algeria *C. rubellus* and *Galerina camerina*.

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