First Look at the Diversity of Macromycetes in the State Forests of the Tebessa Region, Algeria, North Africa

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Abstract:

Background and Aims : The state forests of the Tebessa region (extreme north-east of Algeria) are located in an altitudinal zone of 1000 to 1600m, with a semi-arid bioclimatic zone, are essentially composed of an association of the two species Pinus and Quercus. However, no ecological and taxonomic study of ectomycorrhizal forest fungi, as environmental bio-indicators has been conducted in this region. To this effect, the objective of our research is to gain knowledge of the fungal diversity in order to give a first overview of the Tebessian mycotaxonomy, for implementation a strategy adapted to determine the degree of degradation of these forest environments.

Method : Field trips were made to the 13 selected sites, from September to June, for two years (2020-2022), at a rate of two trips per month. Carpophores harvested, were identified macro- and microscopically on the basis of the identification keys given in a specialised bibliography. The specimens were subsequently kept in the mycological herbarium of the research laboratory «Functional and Evolutive Ecology», Faculty of Natural and Life Sciences, Chadli Bendjedid El Tarf University.

Results : A total of 22 taxa were identified and divided into 05 orders, 16 families and 21 genera. The most represented families are Agaricaceae, Tricholomataceae and Boletaceae. Ectomycorrhizal and saprophytic humicolous species are the most dominant. The ecology of the superior fungi collected revealed a close association between Quercus ilex and Leccinum lepidum, Astraeus hygrometricus, Cortinarius orellanus.

Conclusions : These preliminary data are integrated in the determination of the ectomycorrhizal fungal diversity of Algeria, which is still rare and little known. We can also, through the results

obtained, put in place an appropriate strategy for determining the degree of degradation of these forest environments,

Key words: mycotaxonomy, humicolous saprophytes, ectomycorrhizal, Quercus ilex.

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I. Introduction

Algeria is a great centre of biological dive,rsity ; its geographical position and the structure of its bioclimatic layers make its terroirs a relatively large pool of genetic resources. The state forests of the Tebessa region represent part of this biodiversity. In its forests, fungal species, in particular macromycetes, play an irreplaceable role in the ecology of all ecosystems **(Bâ et *al.*, 2012)** and participate in various ways in the survival of organisms **(Lange, 2014)**. As a result, ectomycorrhizal fungi contribute to the regeneration of natural forests and secondary, as well as the environmental balance **(Bâ, 2011 ; Lange, 2014 and Diédhiou et al., 2013).** However, knowledge of the fungal diversity in the forests of the Tebessa region is not well known. Some fragmentary research work has been carried out in wet to sub-humid areas revealing a significant fungal diversity. We can cite the work of **Maire (1916, 1922, 1930 and 1934)** realized in the forests of Baïnem (Algiers), whose mycological herbarium of collected species is present in the Natural History Museum of Montpellier (France), thus constituting, the only basic bibliographical reference on the ecology and knowledge of North African fungi. More recent work, carried out by **Nezzar-Hocine et al., (1996) and Nezzar-Hocine (1998)** in the cedar forest of the Djurdjura massif, which led to the identification of 100 species out of 120 collected, belonging mainly to the orders Tricholomatales, Cortinariales and Russulales. The mycological inventory of **Beddiar (2002)** carried out in the forests of Séraidi and El Kala (north-east Algeria) revealed a great wealth of fungi, especially ectomycorrhizal fungi, of which 40 species are associated with cork oak, 50 species with Zen oak and 10 species with chestnut. The most frequent species belonged mainly to the genera : *Amanita*, *Boletus*, *Cortinarius*, *Hygrophorus*, *Lactarius*, *Lepiota* et *Russula*. The work of **Djelloul and Samraoui (2011)** and **Djelloul (2014)** on the ecology of macromycetes and their distribution in the alder forests of El Kala National Park (north-east Algeria) have led to the identification of 304 species of which 23 are newly reported. This addition to thatthe checklist of the Kabylia of Babords sub-area, with the census of 12 newly described fungi for Algeria **(Youcef-Khodja et al., 2020).**

Our present research work, which constitutes the continuity of fungal investigations in Algeria, has for objective to give an initial overview of the state of knowledge on the diversity of macromycetes in the state forests of the Tebessa region to enable integrated and sustainable management of these fragile ecosystems. This forest is known for its dominance of *Pinus halpensis* and *Quercus ilex,* has not been studied in terms of mycology. Therefore, the results obtained will serve as a database of Fungi taxa.

II. Materials and Methods

II.1. Study area

The region of Tébessa is located in the North-East of Algeria at GPS coordinates 34° 15' to 35° 45' N; 7° 30' to 8 30' W, with an extension area of 14227 Km2. It is part of the high plains of Constantine and is surrounded by a series of mountains, belonging to the Algerian High Plateaux, which lie between the Tellian Atlas in the north and the Saharan Atlas in the south; located in the altitudinal zone from 1000 to 1600m (Bouguessa-Cheriak, 2017). The vegetation in the study area is typical a semi-desert formation with grasslands and shrubs. Its forests include mainly Aleppo pines (Pinus halepensis Mill., 1768) and and holm oaks (Quercus ilex L.), which develop on their massifs (Le Houerou, 1995). Most of the soils in this area are Haplic Calcisols (CLha), characterised by a high content of calcium carbonates (Dewitt et al. 2013 ; Halitim, 1988) and low in organic matter. The climate of the study area is continental, characterized by two clear-cut seasons; a wet season (from November to April) and a dry season (from May to October). The climate data provided by Azzouc (1975) indicate an average annual temperature of 15.8°C; with an average maximum temperature of 34.8°C in July and an average minimum temperature of the coldest month of 1.9°C during January. Atmospheric precipitation is low, the annual average is up to 338mm. Rain falls mainly in autumn and winter; Most often it is torrential rains which only accentuate the effect, the phenomenon of erosion. In effect, To this is added another important climatic element The prevailing winds are those from North and West, that bring rain during the wet season, as well as the hot drying winds from the southwest, with a higher frequency in summer.

For the realization of our mycological prospections, we chose 13 sites, distributed at the level of the 4 sectors of the state forests of the Tebessa region (Yahia Ben Taleb forests, Nemmamcha forests, Brarcha Alaouna forests and Tebessa forests). The area of the sites varies from 1000m² to 5000m² depending on the homogeneity of the vegetation cover :

- The mixed forests Holm oak / Aleppo pine area is estimated at 1000 m^2
- The homogeneous Holm Oak forests area is estimated at 5000 m^2

Table 01 includes all the sites visited, specifying GPS coordinates, altitude, dominant vegetation and the area prospected. The GPS coordinates and altitude of the study sites was collected by a Garmin 72H GPS unit. The information registered allowed the elaboration of a distribution map of the sites, using Arc GIS 10.8 software **(Fig.1)** and **(Fig.2).**

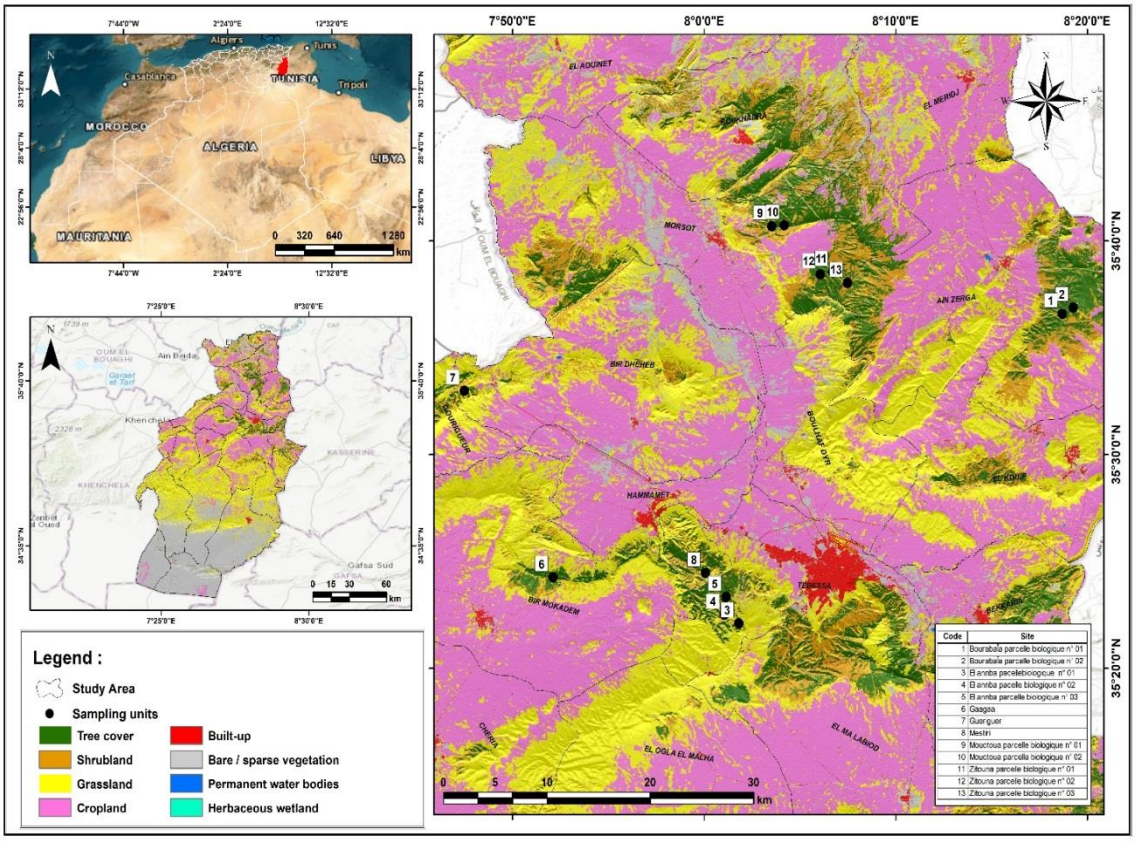
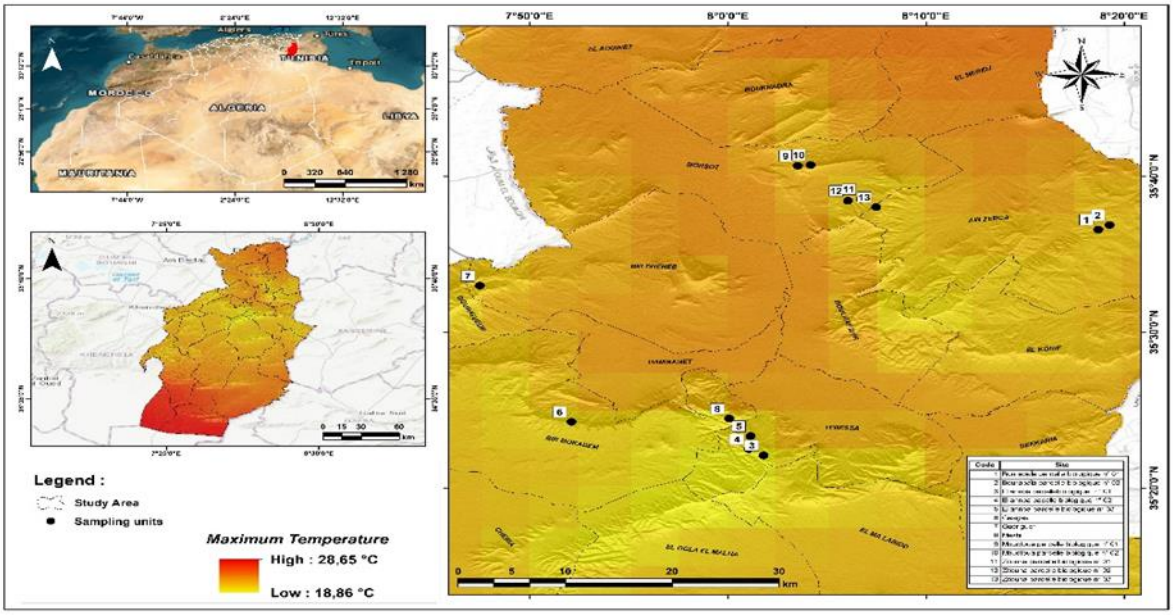


Fig. 1 : Location of mycological prospecting sites (Domanial forest of the Tebessa region, Far North of Algeria)



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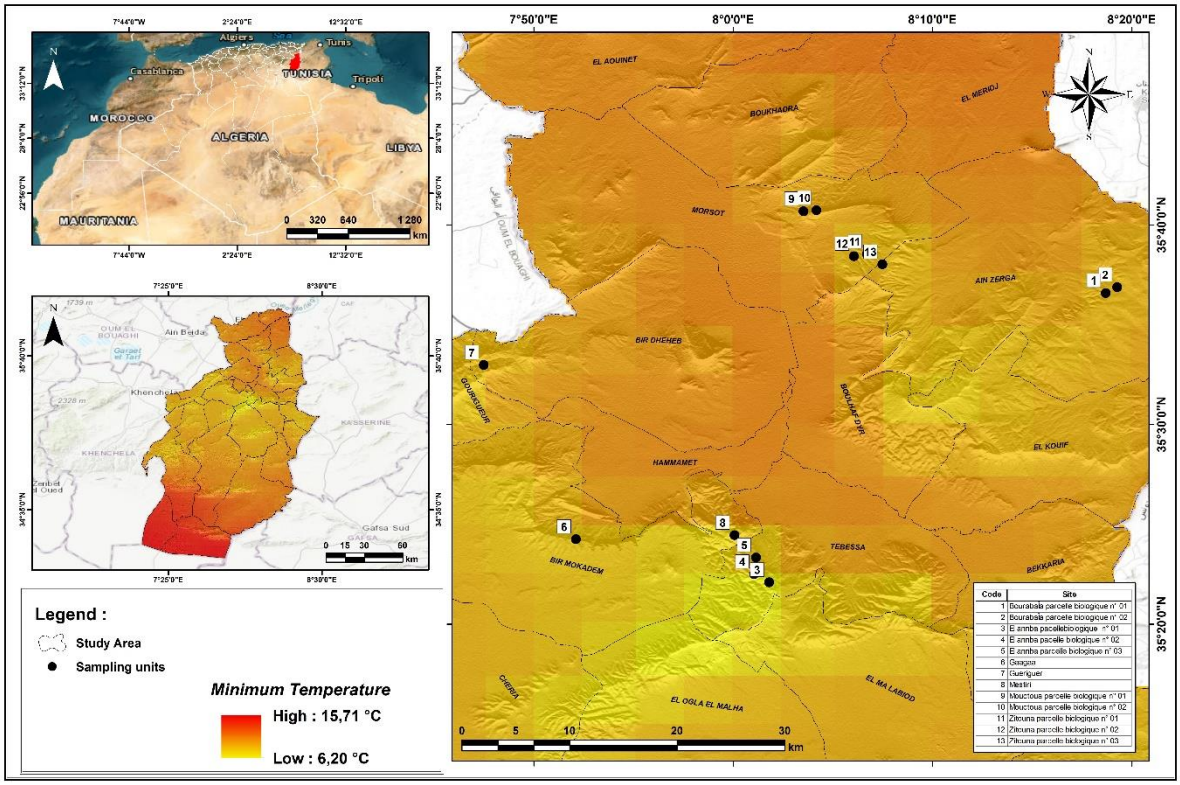

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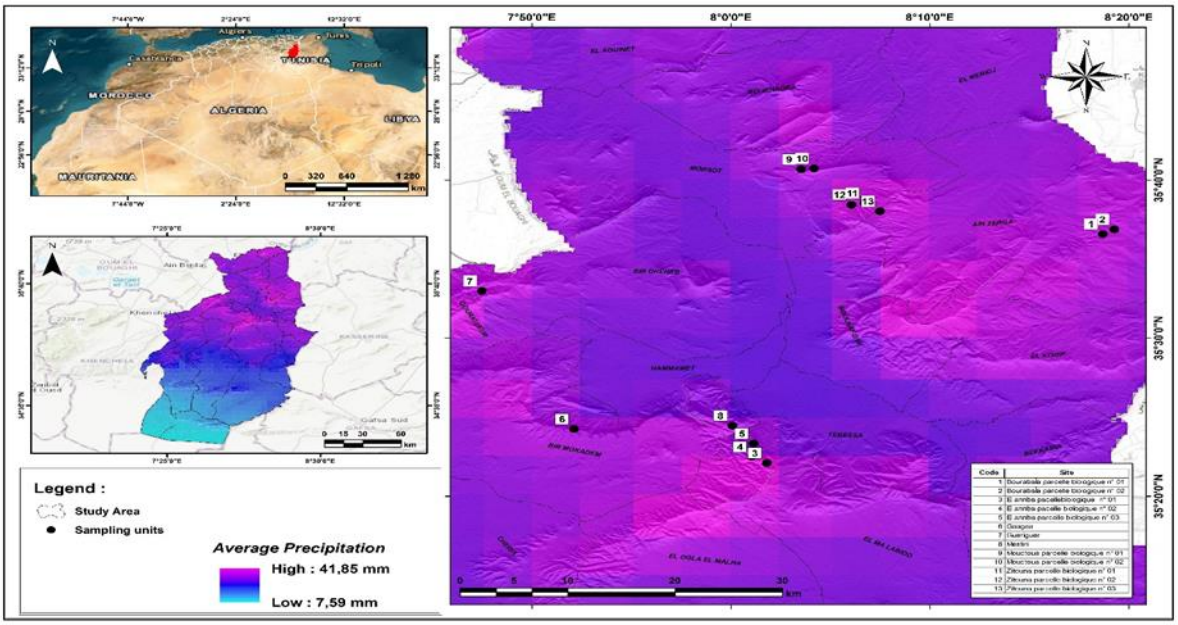
Fig. 2: A : Climatic map of maximum temperature (1958-2021) in the Tebessa region;

B : Climatic map of minimum temperature (1958-2021) for the Tebessa region



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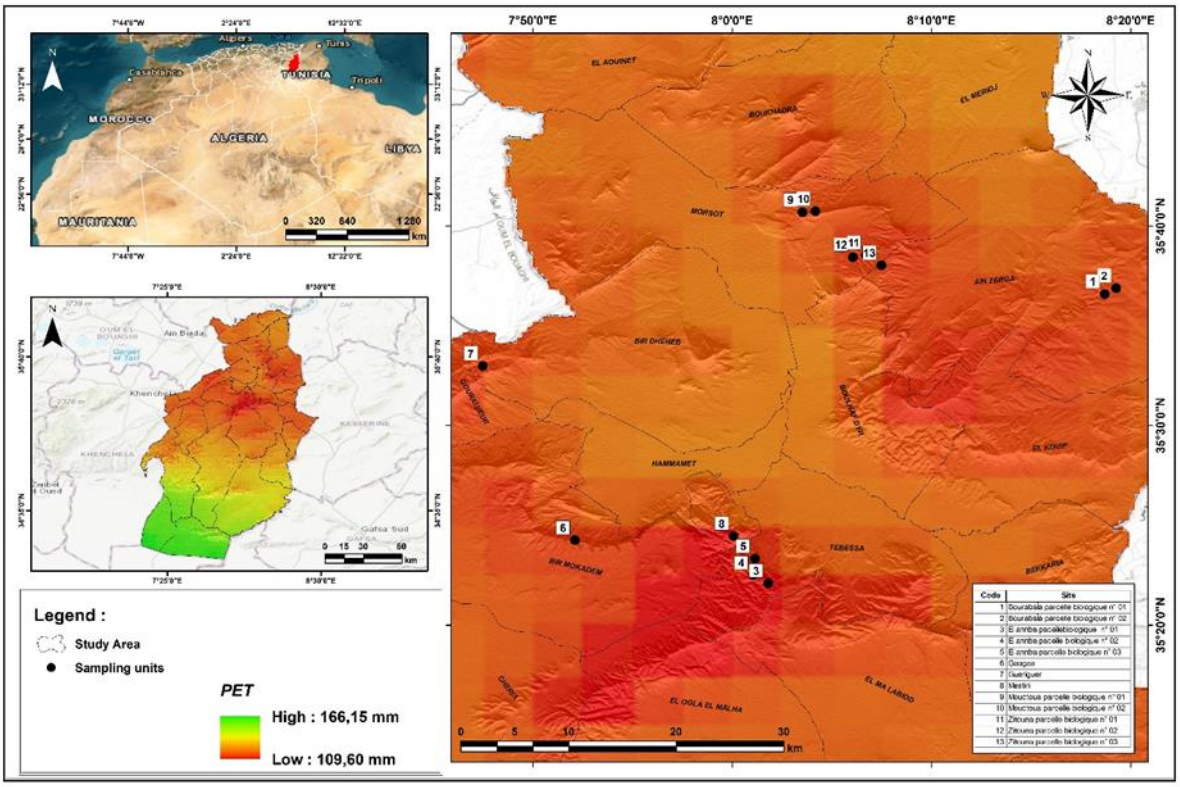

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Fig. 2 : C : Climatic map of precipitation (1958-2021) in the Tebessa region; B : Climatic map of PET (1958-2021) for the Tebessa region.

Table 1 : Characteristics of the 13 sites studied (State forests of Tebessa, North-East Algeria)

	Site 1	Site 2	Site 3	Site 4
Site of study	BourabaÎa 01	BourabaÎa 02	El annba 01	El annba 02
Latitude	35°36'56.808'' N	35° 36'53.386''N	35°22'5.612" N	35°22'30.261" N
Longitude	8°19'15.447'' W	8° 19'16.183'' W	8°1'48.466" W	8°01'3.574" W
Altitude (m)	1080	1082	1523	1456
Dominant vegetation	Holm oak + Aleppo pine	Holm oak + Aleppo pine	Holm oak	Holm oak
Surface area of the site	1000 m^2	1000 m^2	5000 m^2	5000 m^2
	Site 5	Site 6	Site 7	Site 8

Site of study	El annba 03	Gagaa	Gueriguer	Mestiri
Latitude	35°23'20.353" N	35°24'15.122'' N	35°32'59.168'' N	35°24'27.670'' N
Longitude	8°1'9.085" W	7°52'6.894" W	7°47'29.131'' W	8°0'4.362'' W
Altitude (m)	1231	1278	1315	1358
Dominant vegetation	Holm oak	Holm oak + Aleppo pine	Holm oak	Holm oak + Aleppo pine
Surface area of the site	5000 m^2	1000 m^2	5000 m^2	1000 m^2

	Site 9	Site 10	Site 11	Site 12
Site of study	Mouctoua 01	Mouctoua 02	Zitouna 01	Zitouna 02
Latitude	35°40'41.702'' N	35°40'42.686'' N	35°38'32.956" N	35°38'30.72" N
Longitude	8°3'31.728'' W	8°3'56.017'' W	8°6'42.886"W	8°6'45.951" W
Altitude (m)	1061	1080	1189	1199
Dominant vegetation	Holm oak + Aleppo pine	Holm oak + Aleppo pine	Holm oak + Aleppo pine	Holm oak + Aleppo pine
Surface area of the site	1000 m^2	1000 m^2	1000 m^2	1000 m^2

	Site 13
Site of study	Zitouna 03
Latitude	35°38'23.329" N
Longitude	8°6'51.325" W
Altitude (m)	1220
Dominant vegetation	Holm oak + Aleppo pine
Surface area of the site	1000 m^2

II.2. Data analysis

With the aim of to carry out a representative mycological inventory thus meeting the objectives originally tracks, we have adopted a sampling method caractirising at best to types of prospected environment (forest environment in our case). This chosen sampling method takes the form of transects with regular pointing. It should be noted that the forest ecosystem is characterised by a set of numerous micro-situations within a globally homogeneous ecosystem, thus justifying the choice of protocol.

The collection of carpophores was carried out at the 13 selected sites, during two mycological seasons, from September 2020 until June 2022, at the rate of two exits per month. Two interruptions of the prospections are recorded, the month of January (very low temperature) and the month of July corresponding to high heat. The collected macromycetes were photographed *in situ* using a Nikon DX VR camera.

The specimens were identified before being dried and packaged in Nasco WHIRL-PAK clear plastic bags and put in a herbarium according to the method proposed by **De Kesel et al. (2002)**. Taxa identifications were made with the help of a rich and specialised bibliography, comprising numerous books and articles dealing with the taxonomy of Mediterranean and North African fungi. We can mention especially those of **Malençon and Bertault (1970, 1975) ; Roux (2006) ; Eyssartier and Roux (2017) ; N'Douba et al. (2013) ; Courtecuisse and Duhem (1995 ,2013).**

The methodology adopted for the identification of the collected mushrooms is based on a :

- Macroscopic identification : macroscopic description of the collected specimen taking into consideration the different parts (cap, foot, hymenophore and flesh), adding to this the observations of macrochemical reactions.
- Organoleptic identification : determination of smell and flavour.

  Microscopic identification : microscopic description of spores (size, ornamentation, staining),
- asci/basidia, paraphyses, flesh cells (cap and foot) and cystids.
- Ecological identification : plant association, soil type, altitude of harvest site, substrate.

Thus, a detailed description sheet, including the above-mentioned information, was drawn up for each identified fungi.

The dried specimens accompanied by their descriptive sheets are kept in the form of exsiccata and deposited in the herbarium of the research laboratory "Functional and Evolutionary Ecology", Faculty of Natural and Life Sciences, Chadli Bendjedid University -El Tarf-. The classification of the collected fungi was confirmed using the database

III. Results

Based on consultation and examination of the specimens collected, the scientific names of the species and their taxonomy have been validated, by examining a total of 309 fungal specimens corresponding to 22 identified taxa (fig.3) divided into 21 genera and 16 families included in 5 orders of which all belong to the group of basidiomycetes. The most representative orders were the Agaricales, with 9 families divided into 13 genera in which 14 species were identified, followed by the Boletales with 4 families, 5 genera and 5 species.

(table2).

Fig. 3: A. Ampulloclitocybe clavipes (Pers.) Redhead, Lutzoni, Moncalvo & Vilgalys; B. Calvatia gigantean (Batsch ex Pers.) Lloyd; C. Clitocybe nebularis (Batsch), P.Kumm. D. Conocybe tenera (Schaeff.) Fayod ; E. Agaricus campestris L.; F. Agaricus xanthoderma Genev.

Fig. 3: G. *Coprinopsis marcescibilis* (Britzelm.) Örstadius & E.Larss.; H. *Cortinarius orellanus* Fries; I. *Craterellus cornucopioide* (L.) Pers. ; J. *Geastrum fimbriatum* Fr. K. *Gymnopus erythropus* (Pers.) Antonín, Hallin & Noordel ; L. *Astraeus hygrometricus* (Pers.) Morgan.

Fig. 3: M. *Lactarius subdulcis* (Pers. ex Fr.) Gray; N. *Leccinellum lepidum* (H.Bouchet); O. *Apioperdon pyriforme* (Schaeff.) Vizzini; P. *Paralepista flaccida* (Sowerby)Vizzini; Q. *Neoboletus luridiformis* (Rostk.) Gelardi, Simonini & Vizzini (2014); R. *Paxillus involutus* (Batsch) Fr.

Fig. 3: *S. Suillus granulatus* (L.) Roussel *;* T. *Podaxis pistillaris* (L.) Fr.; U. *Tricholoma dryophilum* (Murrill) Murrill

Table2 : Richness of recorded taxonomic groups of fungi collected from 13 selected sites in the state forests of the Tebessa region, Algeria.

Phyla	Class	Órder	Family	Genera	Taxa
Basidiomycota	Agaricomycetes	Agaricales	9	13	14
		Boletales	4	5	5
		Cantharellales	1	1	1
		Geastrales	1	1	1
		Russulales	1	1	1
		Total	**16**	**21**	22

The most diverse families were the Agaricaceae with 4 species (18.18%), followed by the Tricholomataceae with 3 species (13.63%), and Boletaceae with 2 species (9.09%) (Fig.4). When talking about species richness, all the genera contained only one identified species except the genus Agaricus Genev which has 2 species.

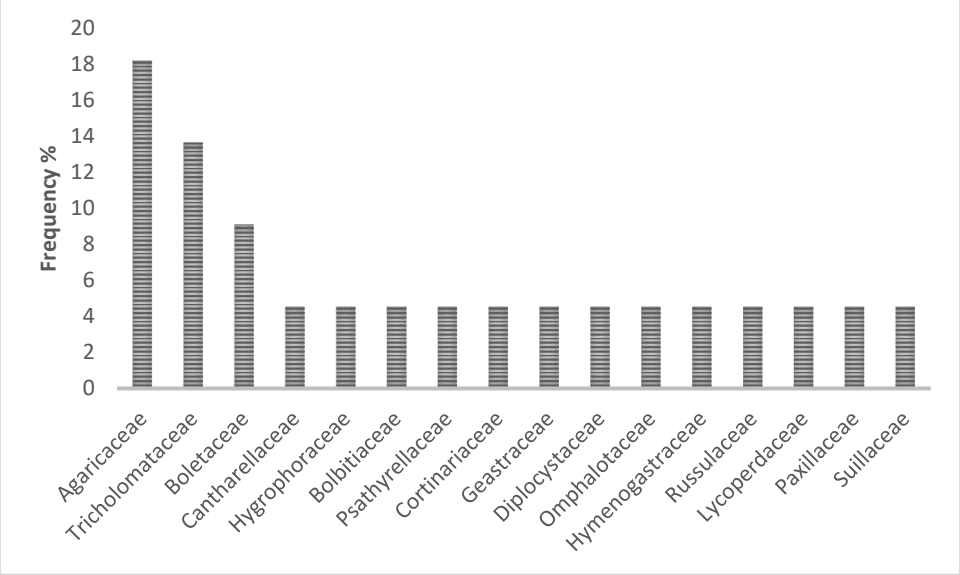


Fig. 4: Frequency of families.

The site 13 (Zitouna 3) was the best represented by species with 13 taxa identified, it is characterized by the dominance of Pinus halepensis with Quercus ilex, whose associated species are Agaricus xanthoderma Genev. , *Neoboletus luridiformis* (Rostk.) Gelardi, Simonini & *Vizzini , Clitocybe nebularis (Batsch), P.Kumm,, Paralepista flaccida (Sowerby)Vizzini , Cortinarius orellanus Fries; Podaxis pistillaris(L.) Fr., Geastrum fimbriatum Fr., Suillus granulatus (L.) Roussel, Hebeloma pseudoamarescens (Kühner & Romagn.) P. Collin, Tricholoma dryophilum*

(Murrill) Murrill, Astraeus hygrometricus (Pers.) Morgan ; Leccinellum lepidum (H.Bouchet ex Essette) Bresinsky & Manfr.Binder.

Through the results of the figure 5, we can see that the percentage of humicolous ectomycorrhizal and saprophyte species are the most dominant, and constitute 41% for both of the whole, against 14% of lignicole saprotrophs, 5% of the saprophytes place to fire.

The ecology of collected higher fungi revealed a close association between Quercus ilex and Leccinum lepidum, Astraeus hygrometricus, Cortinarius orellanus. This is the case for ectomycorrhizal species specific to holm oaks.

Agaricus xanthodermus, Clitocybe nebularis, Calvatia gigantea (Batsch ex Pers.) Lloyd, were identified as humicolous saprophytes. Paralepista flaccida, Gymnopus erythropus (Pers.) Antonín, Hallin & Noordel , Apioperdon pyriforme (Batsch ex Pers.) Lloyd were identified as lignicolous saprophytes. Hebeloma pseudoamarescens was the only taxa that represents saprophytes place to fire. It should be noted that all the 22 taxa identified were reported in Algeria and North Africa

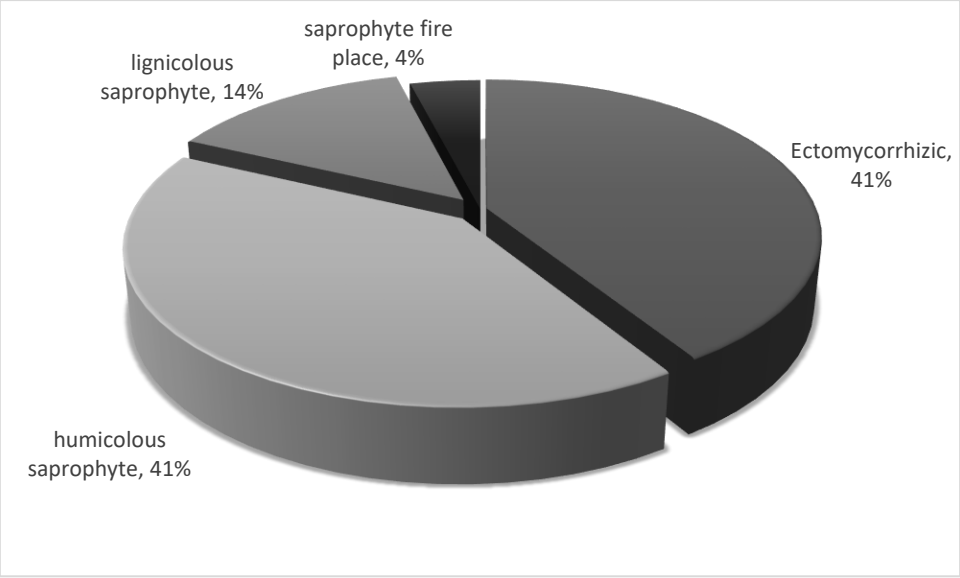


Fig. 5: Distribution of collected taxa according to ecology.

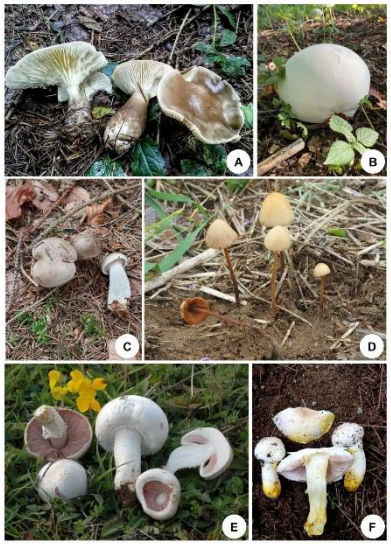
IV. Discussion

A total of 309 specimens of higher fungi were collected, including 22 taxa identified in the state forests of the Tebessa region. This diversity illustrates that the diversity of macromycetes in the forests of North Africa is enormous, this is what he proved by Ouali et al. (2020). At the specific level, the total number of taxa identified remains very low, this is related to the unavailability of identification keys and the fact that there are undoubtedly many undescribed species. Until this day, several North African countries do not yet have data on the specific diversity of macromycetes in the different types of plant formationsUnlike some Latin American countries,

the works based on mycodiversity is often regional, in Mexico we can cite among others inventories that reflect a greater richness in fungal species, 221 taxa reported by **Reynoso-Dueñas et al. (2006)** and 233 by **Sánchez-Jácome and Guzmán-Dávalos (2011) and 311 by Rodríguez Alcántar et al. (2019)**

The Agaricaceae family was one of the most represented in terms of species, which means that this family of macromycetes can account for almost a quarter of the fungal diversity in this region. A similar situation has been observed in other regions of Mexico, as recorded by **Gándara et al. (2014), Padilla-Vélarde et al. (2016)** et **Rodríguez Alcántar et al. (2019)** or as quoted by **Rodríguez et al. (2018), Ayala-Sánchez et al. (2015).**

At the ecological level, there is a significant difference between the taxa collected. The results showed that ectomycorrhizal species dominate in the forests of the study area. This is linked to the density of ectomycorrhizal trees in the formations explored, In these trainings, the fungi are obviously involved in maintaining mycorrhised trees (Duponnois et al., 2011), as observed in certain regions of Mexico. **(García Jiménez et Valenzuela Garza, 2005 ; Chanona-Gómez et al., 2007 ; Pardavé Díaz et al., 2007 ; Vázquez Mendoza and Valenzuela Garza, 2010 ; Rodríguez Alcántar et al., 2019).**



V. Conclusion

The present article has reported the current knowledge of the diversity of macromycetes in the state forests of the Tebessa region. We would like to point out that the number of species identified represents only a fraction of the mycoflora of the surveyed sites in the forests of the study area because there are no previous studies. This is considered a preliminary inventory of fungal species. With specialists, further studies will focus especially on ectomycorrhizal fungi such as ,the species of Boletales, Russula, Lactarius et Cantharellus, Amanita, a detailed study at national level would provide useful information on diversity, The ecology and endogenous

knowledge of ectomycorrhizal macromycetes in Algeria, it would also allow for their optimal management, and their valorisation for sustainable conservation **(Zotti et al. 2013),** investigations on selected ectomycorrhizal associations could be undertaken in order to reconstruct a phylogeographic distribution that constitutes a potential reforestation utility. These investigations will be based on the study of mycorrhizae.

VI. Literature cited

[1] Azzoug A., 1975 Climatologie de la Wilaya de Tébessa. Rapport polycopié projet Alfa, 2, I.N.A.

[2] Ayala-Sánchez, N., I. E. Soria-Mercado, L. Romero-Bautista,M. López-Herrera, R. Rico-Mora y A. Portillo-López. 2015. In: Pulido-Flores, G., S. Monks y M. López-Herrera (eds.). Estudios de biodiversidad Volumen I. University of Nebraska-Lincoln, NE. Zea Books. Lincoln, USA. 215-226 pp.

[3] Bâ A., Duponnois R., Moyersoen, Abdala G. & Diédhiou A., 2012 a, Ectomycorrhizal symbiosis of tropical African trees? Mycorrhiza, 22, 1 -29.

[4] Bâ A., Duponnois D., Diabaté M. & Dreyfus B., 2011, Les champignons ectomycorhiziens des arbres forestiers en Afrique de l'Ouest : Méthodes d'étude, diversité, écologie, utilisation en foresterie et comestibilité, IRD, 268 pp.

[5] Bâ A.M., Mcguire K.L. & Diédhiou A.G., 201 2b. Ectomycorrhizal symbioses in Tropical and Néotropical forests, CRC press, 37 pp.

[6] Bâ A., Duponnois R., Diabaté M. & Dreyfus B., 2011. Les champignons ectomycorhiziens des arbres forestiers en Afrique de l'Ouest. Méthodes d'étude, diversité, écologie, utilisation en foresterie et comestibilité, 268 pages. IRD éditions.

[7] Beddiar A., (2003). Les symbioses racinaires chez les principales essences forestières spontanées ou introduites dans le Nord–Est algérien (étude particulière de la symbiose quadriparti chez l'aulne glutineux). Thèse Doctorat d'Etat, Univ. Badji Mokhtar, Annaba, Algérie. (non paginer)

[8] Bouguessa-cheriak L. 2017: Contribution à l'identification des ectoparasites de la Cigogne blanche (Ciconia ciconia L., 1758) en milieu urbain à Tébessa (extrême EST de l'Algérie). Premier Congrès Nord-Africain d'Ornithologie. Quatrième Colloque International d'Ornithologie Algérienne. Bejaia : 24 et 25 octobre 2017.

[9] Chanona-Gómez, F., R. H. Andrade-Gallegos, J. Castellanos- Albores y J. E. Sánchez. 2007. Macromicetos del Parque Educativo Laguna Bélgica, municipio d'Ocozocoautla de Espinosa Chiapas, México. Revista Mexicana de Biodiversidad 78: 369-381. DOI: https://dx.doi.org/10.22201/ib.20078706e.2007.002.408

[10] Djelloul, R. (2014). Cartographie des champignons au niveau du Parc National d'El Kala (Nord Est Algérien) (Doctoral dissertation, Univ. Badji Mokhtar, Annaba).

[11] Djelloul, R., Samraoui, B. (2011). Distribution and ecology of the superior mushrooms of the Aulnaie of Ain Khiar (El Kala National Park, Northeastern Algeria). African Journal of

Environmental Science and Technology, 5(6): 448–456. doi.org/10.1080/14772000.2014.967823

[12] Dewitte, O., Jones, A., Spaargaren, O., Breuning-Madsen, H., Brossard, M., Dampha, A., & Zougmore, R. (2013). Harmonisation of the soil map of Africa at the continental scale. Geoderma, 211, 138-153.

[13] Diédhiou A.G., Ebenye H.C.M., Selossé M A., Awan A.N.O. & Bâ A.M., 201 3, Diversity and community structure of ectomycorrhizal fungi in mixed and monodominant African tropical rainforest, In Tropical and Neotropical forest. (eds) Bâ AM, McGuire KL and Diédhiou AG (201 3) CRC Press.

[14] De Kesel A., Codjia J. T. C. & Yorou N. S., 2000, Ethnomycological knowledge of Benin, Scripta Bot. Belg., 20, 29-30.

[15] De Kesel A., Codjia J.T.C. & Yorou S.N., 2002, Guide des champignons comestibles du Bénin Cotonou, République du Bénin, Jardin Botanique National de Belgique et Centre International d'Écodéveloppement Intégré (CECODI). Impr. Coco-Multimedia, pp 275.

[16] Courtecuisse, R., Duhem, B., 2013. Champignons de France et d'Europe. Delachaux et Niestlé, France.

[17] Courtecuisse, R.; Duhem, B. Mushrooms & Toadstools of Britain and Europe.; HarperCollins, 1995;

[18] Eyssartier, G., Pierre, R., 2017.Le guide des champignons France et Europe 3100 espèces 1500 photos, 4th ed. Belin, Paris, France.

[19] Gándara, E., L. Guzmán-Dávalos, G. Guzmán y O. Rodríguez. 2014. Introducción a la micobiota de la región de Tapalpa, Jalisco,México. Acta Botanica Mexicana 107: 165-185. DOI: https:// doi.org/10.21829/abm107.2014.207

[20] García Jiménez, J. y R. Valenzuela Garza. 2005. Hongos macromicetos. Historia Natural El Cielo, México. Universidad Autónoma de Tamaulipas. Ciudad Victoria, México. 32 pp

[21] Halitim, A. (1988). Sols des régions arides d'Algérie. OPU, Alger, 384 p.

[22] Heinemann P, 1978. Volvariella (Pluteaceae), complément. Flore illustrée des champignons d'Afrique centrale 6: 107-120.

[23] Heinemann P. & Rammeloo J., 1989. Tubosaeta (Xerocomaceae, Boletineae). Flore illustrée des champignons d'Afrique centrale 14 : 321-335.

[24] Härkönen M., Niemelä T. & Mwasumbi L., 2003. Tanzanian Mushrooms. Edible, harmful and other fungi, Noorlinea 10. Helsinki. Botanical Museum Finnish Museum of National History, University of Helsinki, 200 pages.

[25] Index Fungorum (http://www.indexfungo rum.org/). Consulté le 25/12/2021.

[26] Lange L., 2014, The importance of fungi and mycology for addressing major global challenges, IMA Fungus, 5, 2, 463- 471.

[27] Le Houerou, H.N. (1995). Bioclimatologie et biogéographie des steppes arides du Nord de Afrique. Diversité biologique, développement durable et désertisation. CIHEAM, Options Méditerranéennes, Séries B, 10, 396 p.

[28] Maire, J–C., Moreau, P.–A., Robiche, G. (eds). (2009). Complément à la Flore des champignons du Maroc de Malençon, G. & Bertault, R. Nice, F. : Confédération Européenne de Mycologie Méditerranéenne, 775p.
[29] Malençon G., Bertault R., (1975). Flore des champignons supérieurs du Maroc, Tome II. Trav. Inst. Sci.Chérifien et Fac. Sci. Rabat, sér.Bot . Biol.veg. n° 33, p. 1-541.
[30] Malençon, G., Bertault, R. (1970). Flore des champignons supérieurs du Maroc. Tome I. Trav. Inst. Sci.Chérifien et Fac. Sci. Rabat, sér.Bot. Biol.veg. 32, p. 1-604.
[31] Nezzar–Hocine H., (1998). Associations mycorhiziennes naturelles de Cedrus atlantica dans le massif de Djurdjura (Algérie) et mycorhization contrôlée, Thèse Doctorat, Univ. Blaise Pascal, Clermont–Ferrand, France.
[32] Nezzar–Hocine, H., Bouteville, R. J., Halli–Hargas, R., Chevalier, G. (1996). La macroflore fongigue de Cedrus atlantica (Endl). Manetti ex. Carrière. I–Inventaire des espèces d'une cédraie du massif du Djurdjura (Algérie) et connaissances actuelles sur les champignons des cédraies. Cryptogamie Mycologie, 17(2), 85–103.
[33] N'douba, A.P.; TOUHAMI Ouazzani, A.; Benkirane, A.; Zidane, R.; DOUIRA, A. Etude de Cinq Espèces Coprophiles Du Genre Panaeolus (Fr.) Quélet. Dont Trois Nouvelles Pour Le Maroc : Panaeolus Ater, P. Olivaceus et P. Semiovatus. Bull. L'Institut Sci. Rabat Sect. Sci. Vie 2012, 34, 71–74.
[34] Ouali, Z., Compagno, R., Sbissi, I., Gargano, M.L., Rhaiem, A., Ben Naceur, M., Venturella, G., Jaouani, A., 2016. A preliminary check list of macromycetes in northern Tunisia. Plant Biosyst. 152, 31–58. https://doi.org/10.1080/11263504.2016.1244119
[35] Padilla-Velarde, E. E., G. Zarco-Velazco, L. Guzmán-Dávalos y R. Cuevas-Guzmán. 2016. Primera contribución al conocimiento de macromicetes de la vertiente norte del cerro El Cípil, en la costa sur de Jalisco. Acta Botanica Mexicana 114: 137-167. DOI: https://doi.org/10.21829/ abm114.2016.1105
[36] Pardavé Díaz, L. M., L. Flores Pardavé, V. Franco Ruíz Esparza y M. Robledo Cortés. 2007. Contribución al conocimiento de los hongos (macromicetos) de la Sierra Fría, Aguascalientes. Investigación y Ciencia 37: 4-12.
[37] Pegler D.N., 1977. A preliminary agaric flora of East Africa. Kew Bulletin 35(3) : 475-491.
[38] Reynoso-Dueñas, J. J., L. Hernández-López, R. Ramírez-Delgadillo, M. Harker, M. Cedano-Maldonado e I. L. Álvarez-Barajas. 2006. Catálogo preliminar de la flora vascular y micobiota del municipio de San Sebastián del Oeste, Jalisco, México. Ibugana 14(1-2): 51-91.
[39] Rodríguez, O., D. Figueroa-García y M. J. Herrera-Fonseca. 2018. Catálogo de los hongos del Volcán de Tequila, Municipio de Tequila, Jalisco, México. Polibotánica 45: 15-33. DOI: https://dx.doi.org/10.18387/polibotanica.45.3 Rzedowski, J. 1978. Vegetación de México. Editorial Limusa. Cd. Mx., México. 432 pp.
[40] Rodríguez Alcántar, O., D. Figueroa García y M. J. Herrera-Fonseca. 2018(2019). Catálogo de los hon- gos de San Sebastián del Oeste, Jalisco, México. Acta Botanica Mexicana 126:

e1364. DOI: 10.21829/ abm126.2019.1364
[41] Roux, P., 2006.Mille et un champignons. Roux, Sainte-Sigolène, France.
[42] Sánchez-Jácome, M. R. y L. Guzmán-Dávalos. 2011. Hongos citados para Jalisco, II. Ibugana 16: 25-60.
[43] Vázquez Mendoza, S. y R. Valenzuela Garza. 2010. Macromicetos de la Sierra Norte del Estado de Puebla, México. Naturaleza y Desarrollo 8(1) : 46-61.
[44] Youcef Khodja, L., Rahmania, F., Courtecuisse, R., Moreau, P.-A., 2020. First check-list with the occurrence of new records of Agaricomycetes (Fungi, Basidiomycota) in Babors Kabylia (Northern Algeria). Ecol. Mediterr. 46, 5–25.
[45] Zotti M, Persiani A, Ambrosio E, Vizzini A, Venturella G, Donnini D, Angelini P, Di Piazza S, Pavarino M, Lunghini D, et al. 2013. Macrofungi as ecosystem resources: conservation versus exploitation. Plant Biosyst. 147(1):219–225.