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Ecological characterization and evaluation of the floristic potential of the forest of Doui Thabet (Saida - Western Algeria) in the context of the restoration

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ABSTRACT

Strategies for the restoration and conservation of degraded natural ecosystems begin by understanding the behavior of vegetation in its composition and dynamism and approaching the process of degradation and assessment of these potentials. This work involves evaluating and characterizing the vegetation cover in the Doui Thabet area, which will allow a good restoration plan to be developed. The inventory was completed during the period 2017-2019. The result revealed the existence of 344 taxa divided into 223 genres and 77 families including 31 rare taxa, 25 endemic and 9 protected. In addition, the results obtained in calculating the biological indices to conclude that this ecosystem are deteriorating. Grazing and land clearing were reported as direct factors impacting degradation, while land tenure was the most cited indirect factor.

Keys word : *Restoration, Degraded ecosystems, Evaluate, Characterize, Doui Thabet.*

Introduction

From an ecological point of view, the Mediterranean basin is considered a hot spot because of its very important biological diversity, including endemic plant species. The estimated plant richness of 25,000 species. Mediterranean-type forests account for about twice as many woody species as European-type forests (247 versus 135) (Quézel *et al.*, 1999 ; Barbero *et al.*, 2001 ; Quézel and Medail, 2003).

This plant diversity varies from country to country depending on geographical location. The plant richness of the North Africa is estimated between 5,000 to 5300 species, represents 15% of that of the Mediterranean basin (Quézel, 2000). This wealth is represented by 3800 species, 900 of which are endemic to Morocco. It is 3150 taxa in Algeria, of which 320 are endemic and 160 species, 39 of which are endemic in Tunisia (Medail *et al.*, 1997).

Algeria, the largest country in Africa, has a great diversity of ecosystems (coastal region, tell, steppes, Sahara, wetlands...). This plant diversity is estimated at about 3193 species according to Quézel (1962), 3744 taxa according to Véla and Benhouhou (2007), 3150 species of which 700 endemic according to Medail (1997) and 454 species, of which 75 orchids are protected under Ministerial Decree (12/03) (JORA, 2012).

On the dynamic level, vegetation cover in Algeria is in irreversible decline due to global changes in

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particular, high anthropogenic and climatic pressure (Bestaoui, 2001; Benabdeli, 2006).

Despite this degradation of natural habitats, Northern Algeria remains rich in plant varieties, especially rare, endemic species, orchids... etc. Babali *et al*. (2014) recorded 650 taxa, spread over 85 families, in the Moutas Hunting Reserve in Tlemcen. Miara *et al*. (2018) have inventoried 566 taxa, spread over 76 families, in the northern region of the Wilaya of Tiaret.

The flora of the Saida region is little known, in terms of composition. The only inventory carried out by Djebbouri and Terras (2019) during the period 2017 to 2018, was concentrated on rare, endemic and protected species in forest formations pre-forests.

The ecosystems of the mounts of Saida like all the composition of the Atlas Tellien Oriental (Tlemcen, Sidi Bel Abbes, Saida, mascara, Tiaret... etc) have experienced continuous regression due to fires, anthropogenic actions, inappropriate management and a low rainfall related to its geographical position. This situation requires urgent restoration and rehabilitation strategies (Benabdeli, 1996; Medjahdi *et al*., 2009; Hasnaoui, 2008; Nasrallah, 2014; Terras, 2013; Babali *et al*., 2014; Kefifa, 2015; Hasnaoui and Nasrallah, 2013; Nasrallah and Kefifa, 2015 and Miara *et al*., 2018.).

In this sense, we process at a phytoecological diagnosis of the ecosystems of the Doui Thabet area in the first step, to develop a strategy restoration of this degraded ecosystem in a second phase. The phytoecological diagnosis is based on the development of a floristic catalogue and the calculation of biological indices, in order to analyze the evolution of plant cover in study area.

Materials and Methods

Region of study

The study area is part of the mounts of Saida, with altitudes ranging from 580 m to El Ache and 1203 m to Djebel Sidi Ahmed Zeggai and an area of 56.31 km^2. It extends for a distance of 30 km East-West and 14 km North -South) (Fig. 1). On Emberger's climagram, the study area is part of the semi-arid bioclimatic floor in the cool winter, with the presence of a few stations with sub-humid climate at the Djebel Sidi Ahmed Zeggai and Ras El Maa. The average annual rainfall is above 350 mm per year; the maximum average annual temperature is 35 °C, the minimum annual average temperature is 2°C and the rain quotient Emberger is 11.20.

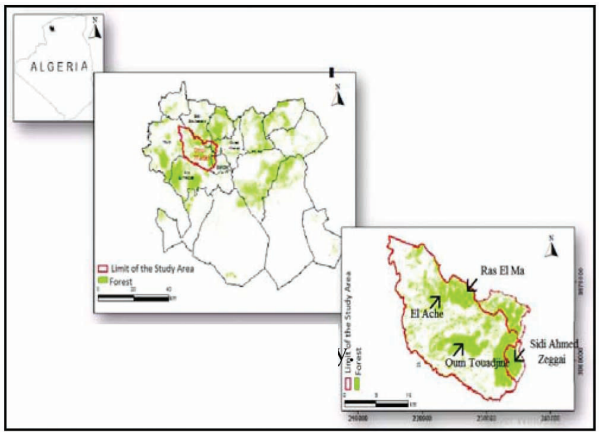

Fig. 1. Region of study.

Methodology

The autumns and spring sets for the completion of the surveys took place in the years 2017 to 2019. Three hundred and twenty three (323) floristic surveys were conducted in the types of stands covering our entire study area (Gehu Rivaz-Martinez, 1981). The number of surveys conducted in each homogeneous area depends on the diversity of ecological descriptors and the extent of each plant formation (Aafi *et al*., 1997; Aafi, 1997).

At the level of each survey, we mentioned geographic coordinates, soil characteristics, orography, substrate, structure and rate of layer recovery as well as the abundance-dominance coefficient (ADC) and sociability of each species.

The identification of taxa was made at the research Laboratory of Ecology and Natural Ecosystems Management at the university Abu Bakr Belkaid of Tlemcen using several reference books such as : Quézel and Santa (1962-1963), Fennane *et al*. (1999), Dobignard and Chatelain (2010-2013) for the updating of flora. Regarding protected taxa in Algeria, we consulted the executive decree (12/03) (JORA, 2012) and the IUCN Red List (IUCN version 3.1, 2001).

Based on the 323 phytoecological surveys carried out, we have calculated the indices cited below that tell us about the ecological health of our forest :

Specific wealth (S)

$S = sp_1 + sp_2 + ..+ spn$

S : Specific wealth; sp : Taxes observed (Ramade, 2003).

Shannon -Wiener index (H')

According to (Blondel, 1979 ; Frontier, 1983 ; Ramade, 2003) :

$$H' = -\sum p_i * log_2 p_i$$

H' : Shannon -Wiener index; pi : The number of individuals.

Fair Trade Index of Piélou (E)

According to Ramade (2003) :

$$E = {H'}/{H'max}$$ with : and

Disturbance Index (Loisel and Gamila, 1993)
DI= Number of chamephyte+ number of therophyte / total number of species.
Net Biological Spectrum (NBS) (Raunkiaer, 1934): The Net Biological Spectrum (NBS) is the rate of each biological type (chamephyte: Ch, therophyte: Th, geophyte: Ge, hemicrypotphyte: He, phanephyte: Ph.).

Results

Floristic catalog

Phytoecological surveys conducted in the field have led to the development of this flora catalog. It contains 344 taxa which are classified by family in alphabetical order according to the new nomenclature of Dobignard & Chatelain (2010-2013) (Table 1).

Biological indices of the study area

On the base plant studies carried out, we determined the rate of each biological type (Fig. 2) and calculate the 4 biological indices of the study area (Table 2).

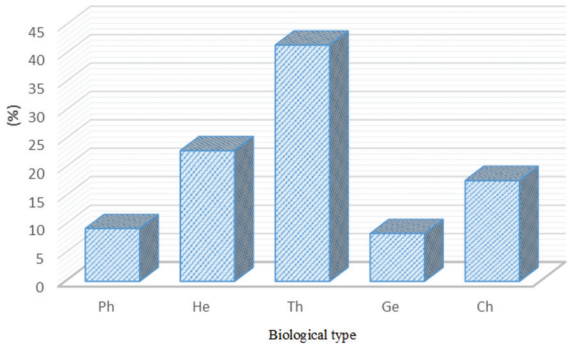

Fig. 2. Biological type.

Discussion

Inventory and systematic

The present study permitted to diagnose ecologically the area of Doui Thabet for the first time by : 1-dressage of a first floristic catalog highlights its richness of flora ; 2-characterization of the state of vegetation and 3-to match its potential. This ecological diagnosis is a reference for the work of future research (diachronic studies) and decision-makers and managers for landscaping and restoration.

The floristic richness of the study area is 344 taxa or 9.18% of the Algerian flora (3744 taxa) (Dobignard and Chatelain, 2010-2013). These species belong to 223 genres and 77 families of which 8 are clearly dominant. This wealth of flora is divided into the family in the following order: Asteraceae, 60 species, or 17. 44%, Fabaceae 42 species, or 12.20%), Lemiaceae (27 species, or 7.84 %), Brassicaceae (20 species, or 5. 81%, Apiaceae 16 species, or 4.65%), Poaceae (13 species, or 3.77%), Cistaceae (10 species, or 2.90%) and Ranunculaceae 09 species, or 2. 61%. Eight (8) families are known by their acclimatization to the arid conditions of the Saida region and total only1, 97 taxa, or 57.26% of the total wealth of forests. The rest of the families contribute 42.73 % of the total workforce.

The main differences between this study and that of Djebbouri and Terras (2019) can be summered in the following points : The area prospected in our case is 120 times smaller than that of Djebbouri and Terras, on the other hand the difference in the number of species encountered is only 55 species in their favour. Our study presents more than 12 families not mentioned in the Djebbouri study. However, while 35 families are common to the two studies, 27 other families are not common. The differences between the two studies are due to the effectiveness of the sampling method adopted, the period, the campaign numbers and the training set up in each study. It is important to note that the two studies are complementary and contribute to the knowledge of the flora richness of the region.

On a systematic level, this richness is divided among the following groups :

-Pteridophytes: are represented by 3 families: Aspleniaceae with 2 species, Pteridaceae with 2 spe-

Table 1. Floristic catalog of the forest of Doui Thabet.

Family	Taxa
Aizoaceae	*Aptenia cordifolia* (L. f.) Schwantes.
Alliaceae	*Allium cupanii* Raf.
Anacardiaceae	*Pistacia atlantica* Desf.
	Pistacia lentiscus L.
	Pistacia terebinthus L.
	*Rhus tripartita (*Ucria) Grande.
Araceae	*Arisarum vulgare* subsp. *simorrhinum* (Durieu) Maire & Weiller.
Arecaceae	*Chamaerops humilis* L
Araliaceae	*Hedera helix* L.
Asteraceae	*Anacyclus clavatus* (Desf.) Pers.
	Anacyclus pyrethrum (L.) Link
	Anacyclus valentinus auct.
	Andryala integrifolia L.
	Artemisia herba-alba Asso
	Asteriscus maritimus (L.) Less.
	Asteriscus spinosus (L.) Sch. Bip.
	Atractylis caespitosa Desf.
	Bellis annua L.
	Bellis sylvestris Cirillo
	Bombycilaena discolor (Pers.). M. Lainz.
	Calendula arvensis (Vaill.).L
	Calendula bicolor Raf.
	Calendula officinalis L
	Calendula suffruticosa Vahl
	Carduncellus pinnatus (Desf.). DC.
	Carduus nutans L.
	Carduus pycnocephalus L.
	Catananche arenaria Coss. & Durieu.
	Catananche caerulea L.
	Centaurea acaulis subsp. *boissieri* Maire
	Cerinthe aspera auct.
	Cichorium intybus L.
	Cirsium acarna (L.) Moench
	Cirsium echinatum (Desf.) DC.
	Cynoglossum cheirifolium L.
	Cynoglossum mathezii Greuter & Burdet
	Dittrichia viscosa (L.) Greuter.
	Echinops spinosus L.
	Echinops spinosissimus subsp. *spinosissimus*
	Filago pygmaea L.
	Filago pyramidata L.
	Hedypnois cretica (L.) Dum. Cours.
	Helichrysum italicum (Roth) G. Don
	Helichrysum stoechas (L.) Moench
	Hieracium humile Jacq.
	Hyoseris radiata L.
	Hypochaeris radicata L.
	Inula Montana L.
	Leontodon saxatilis Lam.
	Leontodon tuberosus L.
	Mantisalca salmantica (L.) Briq. & Cavill.
	Micropus supinus L.
	Pallenis maritima (L.) Greuter
	Pallenis spinosa (L.) Cass.
	Phagnalon rupestre (L.) DC.
	Phagnalon saxatile (L.) Cass.
	Picnomon acarna (L.) Cass.
	Reichardia tingitana (L.) Roth.
	Rhaponticum acaule (L.). DC.
	Rhaponticum coniferum (L.) Greuter
	Scorzonera laciniata L.
	Scorzonera undulata Vahl
	Senecio vulgaris L.
	Scolymus grandiflorus Desf.
	Scolymus hispanicus L.
	Sonchus maritimus L.
	Silybum marianum (L.) Gaertn.
	Sonchus oleraceus L.
	Tolpis barbata (L.) Gaertn.
Asparagaceae	*Asparagus acutifolius* L.
	Asparagus albus L.
	Dipcadi serotinum (L.) Médi.
Asphodelaceae	*Asphodelus macrocarpus* Parl. subsp. *macrocarpus*
Aspleniaceae	*Asplenium adiantum-nigrum* L.
	Asplenium ceterach L.
Apiaceae	*Ammi visnaga* (L.) Lam.
	Bupleurum lancifolium Hornem.
	Bupleurum rigidum L.
	Bupleurum spinosum Gouan.
	Crithmum maritimum L.
	Daucus carota L. subsp. *carota*
	Eryngium tricuspidatum L.
	Ferula communis L.
	Foeniculum vulgare Mill.
	Helosciadium nodiflorum (L.) W.D.J. Koch
	Magydaris panacifolia (Vahl) Lange.
	Magydaris pastinacea (Lam.) Paol. & Bég.
	Scandix pecten-veneris L.
	Smyrnium Olusatrum L.
	Thapsia garganica L.
	Thapsia villosa L.
Apocynaceae	*Nerium oleander* L.
Boraginaceae	*Borago officinalis* L.
	Echium australe Lam.
	Echium confusum Coincy.
	Echium italicum L.
Brassicaceae	*Alyssum simplex* Rudolphi
	Arabis recta Vill.
	Biscutella cichoriifolia Loisel.
	Cardamine hirsuta L.
	Carrichtera annua (L.) DC.
	Diplotaxis erucoides (L.) DC.
	Diplotaxis harra (Forssk.) Boiss.

Table 1. *Continued ...*

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Family	Taxa
	Diplotaxis virgata (Cav.) DC.
	Hirschfeldia incana (L.) Lagr.-Foss.
	Lepidium didymum L.
	Lobularia maritima (L.) Desv.
	Moricandia arvensis (L.) DC.
	Rhamnus alaternus L. subsp. *alaternus*
	Rhaphanus raphanistrum L.
	Rapistrum rugosum (L.) All.
	Sinapis alba L.
	Sinapis arvensis L.
	Sisymbrium erysimoides Desf.
	Sisymbrium irio L.
	Thlaspi perfoliatum L.
Capparaceae	*Capparis spinosa* L.
Caprifoliaceae	*Lonicera implexa* Aiton
Caryophyllaceae	*Silene coelirosa* (L.) Godr.
	Silene colorata Poir.
	Silene vulgaris (Moench) Garcke.
	Silene laeta (Aiton) A. Braun.
	Vaccaria hispanica (Mill.) Rauschert subsp. *hispanica.*
Cistaceae	*Cistus albidus* L.
	Cistus creticus L.
	Cistus monspeliensis L.
	Cistus salviifolius L.
	Fumana thymifolia (L.) Webb
	Helianthemum cinereum (Cav.) Pers.
	Helianthemum croceum (Desf.) Pers.
	Helianthemum halimioides Pomel.
	Helianthemum pergamaceum Pomel
	Helianthemum syriacum (Jacq.) Dum. Cours.
Colchicaceae	*Merendera filifolia* Cambess.
Convolvulaceae	*Convolvulus althaeoides* L.
	Convolvulus cantabrica L.
	Convolvulus tricolor L.
Cupressaceae	*Cupressus sempervirens* L.
	Juniperus oxycedrus L.
	Tetraclinis articulata (Vahl) Mast.
Cucurbitaceae	*Bryonia dioica* Jacq.
Crassulaceae	*Sedum acre* L.
	Sedum album L.
	Sedum caeruleum L.
	Sedum dasyphyllum L.
	Sedum rubens L.
	Sedum sediforme (Jacq.) Pau
	Umbilicus rupestris (Salisb.) Dandy.
Dipsacaceae	*Scabiosa atropurpurea* f. glabra Font Quer.
	Scabiosa stellata L.
Ericaceae	*Arbutus unedo* L.
	Erica arborea L.

Table 1. *Continued ...*

Family	Taxa
Euphorbiaceae	*Euphorbia falcata* L.
	Euphorbia helioscopia L.
Fabaceae	*Anagyris foetida* L.
	Anthyllis vulneraria L.
	Astragalus boeticus L.
	Astragalus caprinus L.
	Astragalus echinatus Murray.
	Astragalus epiglottis L.
	Astragalus gombo Bunge.
	Astragalus humilis M. Bieb.
	Bituminaria bituminosa (L.) C. H. Stirt.
	Calicotome spinosa (L.) Link
	Calicotome villosa var. *intermedia* (C. Presl) Ball
	Ceratonia siliqua L.
	Colutea arborescens L.
	Coronilla juncea L.
	Coronilla valentina L.
	Cytisus arboreus (Desf.) DC.
	Cytisus monspessulanus L.
	Cytisus triflorus L'Hér.
	Cytisus villosus Pourr.
	Ebenus pinnata Aiton
	Erinacea anthyllis Link.
	Genista cinerea (Vill.) DC.
	Genista hirsuta subsp. *erioclada* (Spach) Raynaud.
	Hedysarum aculeolatum Munby ex Boiss.
	Hedysarum pallidum Desf.
	Lathyrus tingitanus L.
	Lotus ornithopodioides L.
	Lupinus luteus L.
	Medicago intertexta (L.) Mill.
	Medicago marina L.
	Medicago polymorpha L.
	Medicago sativa L.
	Melilotus indicus (L.) All.
	Ononis viscosa L.
	Pisum sativum L.
	Retama raetam (Forssk.) Webb.
	Trifolium campestre Schreb.
	Trifolium cherleri L.
	Trifolium tomentosum L.
	Vicia monantha Retz.
	Vicia sativa L.
	Vicia onobrychioides L.
Fagaceae	*Quercus coccifera* L.
	Quercus faginea Lam.
	Quercus ilex L.
Frankeniaceae	*Frankenia laevis* L.
Gentianaceae	*Centaurium erythraea* Rafn.
	Centaurium spicatum (L.) Fritsch.

Table 1. *Continued ...*

Family	Taxa
Geraniaceae	*Erodium chium* (L.) Willd.
	Erodium ciconium (L.) L'Hér.
	Erodium malacoides (L.) L'Hér.
	Erodium moschatum (L.) L'Hér.
Globulariaceae	*Globularia alypum* L.
Hyacinthaceae	*Ornithogalum baeticum* Boiss.
	Ornithogalum comosum L.
	Ornithogalum umbellatum L.
	Prospero autumnale (L.) Speta
Illecebraceae	*Paronychia argentea* Lam.
Iridaceae	*Gladiolus italicus* Mill.
	Iris tingitana Boiss. & Reut.
	Iris planifolia (Mill.) T. Durand & Schinz.
	Iris sisyrinchium L.
	Iris unguicularis Poir.
Juncaceae	*Juncus capitatus* Weigel.
Lauraceae	*Laurus nobilis* L.
Lemiaceae	*Ajuga iva* (L.) Schreb.
	Ballota hirsuta L.
	Cleonia lusitanica (L.) L.
	Lamium purpureum L.
	Lavandula dentata L.
	Lavandula stoechas L.
	Marrubium vulgare L.
	Mentha pulegium L.
	Nepeta apuleii Ucria
	Nepeta multibracteata Desf.
	Phlomis herba-venti subsp. *pungens* (Willd.) Maire ex De Filipps.
	Rosmarinus eriocalyx Jord. & Fourr.
	Rosmarinus officinalis L.
	Salvia argentea L.
	Stachys officinalis (L.) Trevis.
	Stachys ocymastrum (L.) Briq.
	Teucrium flavum L.
	Teucrium fruticans L.
	Teucrium pollium L.
	Teucrium pseudochamaepitys L.
	Thymus algeriensis Boiss. & Reut.
	Thymus capitatus (L.) Hoffmanns. & Link.
	Thymus ciliatus (Desf.) Benth.
	Thymus fontanesii Boiss. & Reut.= T. pallescens de Noé.
	Thymus hirtus Willd.
	Thymus munbyanus subsp. *abylaeus* (Font Quer & Maire) Greuter & Burdet.
	Thymus numidicus Poir.
Lilliaceae	*Leopoldia comosa* (L.) Parl.
	Tulipa sylvestris L.
Linaceae	*Linum strictum* L.
	Linum suffruticosum L.
Lythraceae	*Lythrum acutangulum* Lag.

Table 1. *Continued ...*

Family	Taxa
Malvaceae	*Malva aegyptia* L.
	Malva parviflora L.
	Malva sylvestris L.
Moraceae	*Ficus carica* L.
Myritaceae	*Eucalyptus camaldulensis* Dehnh.
Neuradaceae	*Neurada procumbens* L.
Oleaceae	*Fraxinus angustifolia* Vahl.
	Jasminum fruticans L.
	Olea europaea L.
	Phillyrea latifolia L.
	Phillyrea angustifolia L. subsp. *angustifolia*
Orchidaceae	*Ophrys lutea* Cav.
	Ophrys tenthredinifera Willd. subsp. *tenthredinifera.*
	Anacamptis papilionacea (L.) R. M. Bateman, Pridgeon & M. W. Chase subsp. *papilionacea.*
	Dactylorhiza elata (Poir.) Soó
Orobanchaceae	*Orobanche gracilis* Sm.
	Orobanche schultzii Mutel.
Oxalidaceae	*Oxalis cernua* Thunb.
Papaveraceae	*Papaver hybridum* L.
	Papaver rhoeas L.
	Papaver pinnatifidum Moris.
Pinaceae	*Pinus halepensis* Mill.
Plantaginaceae	*Plantago coronopus* L.
	Plantago lagopus L.
	Plantago lanceolata L.
	Plantago serraria L.
Poaceae	*Aegilops triuncialis* L.
	Ampelodesmos mauritanicus (Poir.) T. Durand & Schinz.
	Anisantha madritensis (L.) Nevski.
	Arundo donax L.
	Avena barbata Pott ex Link.
	Avena sterilis L.
	Briza maxima L.
	Cynodon dactylon (L.) Pers.
	Echinaria capitata (L.) Desf.
	Phragmites communis Trin.
	Poa bulbosa L.
	Stipa capensis Thunb.
	Vulpia geniculata (L.) Link.
Polygalaceae	*Polygala rupestris* Pourr.
Polygonaceae	*Rumex* bucephalophorus L.
	Rumex conglomeratus Murray.
	Rumex pulcher L.
Primulaceae	*Anagallis arvensis* L.
	Anagallis monelli L.
	Coris monspeliensis L.
Pteridaceae	*Adiantum capillus-veneris* L.
	Cheilanthes acrostica (Balb.) Tod.

Table 1. *Continued ...*

Family	Taxa
Rafflesiaceae	*Cytinus hypocistis* (L.) L.
Ranunculaceae	*Adonis aestivalis* L.
	Adonis annua L.
	Adonis dentata auct.
	Clematis cirrhosa L.
	Clematis ammula L.
	Delphinium peregrinum L.
	Ranunculus bulbosus L.
	Ranunculus macrophyllus Desf.
	Ranunculus millefoliatus auct.= *Ranun culus fibrosus* Pomel.
Resedaceae	*Reseda alba* L.
	Reseda lutea L.
Rhmnaceae	*Rhamnus alternus* L.
	Ziziphus lotus (L.) Lam.
Rosaceae	*Crataegus oxyacantha* var. *monogyna* (Jacq.) Batt.
	Rosa canina L.
	Rubus ulmifolius Schott.
	Sanguisorba minor subsp. vestita (Pomel) Maire.
	Potentilla recta L.
Rubiaceae	*Asperula hirsuta* Desf.
	Galium aparine L.
	Galium mollugo L.
	Galium rotundifolium L.
	Rubia peregrina L.
Ruscaceae	*Ruscus aculeatus* L.
Rutaceae	*Ruta chalepensis* L.
	Ruta montana (L.) L.
Salicaceae	*Salix pedicellata* Desf.
	Populus alba L.
Santalaceae	*Osyris alba* L.
Scrophulariaceae	*Bartsia trixago* L.
	Scrofularia Spreng.
	Verbascum sinuatum L.
Sinopteridaceae	*Cosentinia vellea* (Aiton) Tod.
Simaroubaceae	*Ailanthus altissima* (Mill.)
Smilacaceae	*Smilax aspera* L.
Solanaceae	*Datura meteloides* Dunal.
	Nicotiana glauca Graham.
Tamariaceae	*Tamarix africana* Poir.
Thymelaeaceae	*Daphne gnidium* L.
	Thymelaea hirsuta (L.) Endl.
	Thymelaea virescens Meisn.
Urticaceae	*Urtica dioica* L.
	Urtica urens L.
Valerianaceae	*Fedia cornucopiae* (L.) Gaertn. var. *cornucopiae.*
Zygophyllaceae	*Peganum harmala* L.

Table 2. Biological indices.

Index	(S)	(H′)	(E)	(DI)
Value	344	1.72	2.53	59.30 %

cies and Sinopteridaceae with a single species;

-Gymnosperms: are represented by 2 families: Pinaceae with a single species and Cupressaceae with 03 species;

Angiosperms: comprise 72 families or 335 species including 324 dicotyledones and 14 monocotyledones.

These data show that, in all the forest massifs of the Algerian tell, the same families of plants dominate in the same order almost. Our results confirm the work of phyto-diversity in the subsector of the Atlas Tellien Ornais (O3) including those of Medjahdi *et al.* (2007), Hasnaoui, (2008), Babali *et al.* (2014) and Miara *et al.* (2018).

The perturbation index (PI) = 59.30 %, is close to the threshold advanced by El Hamrouni (1992) in Tunisia in his study; which is 70% and which it has described as very important.

The colonization by asylvatic species shows that the regressive dynamics of this ecosystem to be beautiful and well started. The anthropogenic action due to repeated fires in this area during the period : 1992-2015, large-area clearing, over grazing, over exploitation and poor practices of exploitation of medicinal plants by herbalists unskilled and local population. These degradation phenomena are at the origin of the disappearance of many species that have become endemic, rare and protected, as is the case of genres : *Thymus, Teucrium, Phillyrea, Rosmarinus, Thymelaea, Artemisia, Tetraclinis...*

The climate of the area characterized by a period of drought that lasts 6 to 8 months of the year, contributes in this series of regressive dynamics of vegetation. This result confirms the conclusions put forward by Benabdeli, (2006), Hasnaoui, (2008), Nasrallah, (2013), Terras, (2013), kefifa, (2015), Hasnaoui and Nasrallah, (2015). They all agreed that the plant mat is subject to man-made aggression. In this regard Benabdeli, (2006) pointed out that: the vegetation cover is constantly subjected to human-caused aggressions, against which the rustic vegetation, despite its faculties of resistance, can no longer resist and maintain itself. According to the same author, plant composition are represented only by degraded groups as a whole to such an ex-

Table 3. Rare, endemic and protected taxes from the study area.

Taxa	Rare	Endemic	Protected
Pistacia atlantica Desf.	/	/	Protected in Algeria
Asteriscus spinosus (L.) Sch. Bip.	Very rare	/	/
Atractylis caespitosa Desf.	Rare	End. Alg.Mar Tun Lib	/
Carduncellus pinnatus (Desf.). DC.	Rare	/	/
Hieracium humile Jacq.	/	End. Alg	Protected in Algeria
Rhaponticum acaule (L.). DC.	/	End. Alg.Mar Tun Lib	/
Crithmum maritimum L.	Rare	/	/
Daucus carota L. subsp. *carota*	Rare	/	/
Magydaris panacifolia (Vahl) Lange.	Rare	/	/
Echium australe Lam.	Rare	/	/
Echium confusum Coincy.	Quite rare	/	/
Biscutella cichoriifolia Loisel.	Very rare	/	Protected in Algeria
Rhamnus alaternus L. subsp. *alaternus*	/	End. Alg.Mar Tun Lib	/
Thlaspi perfoliatum L.	/	End. Alg.Mar Tun Lib	/
Helianthemum croceum (Desf.) Pers.	Quite rare	End. Alg.Mar Tun	/
Juniperus oxycedrus L.	/	/	Protected in Algeria
Hedera helix L.	/	End. Alg.Mar Tun Lib	/
Tetraclinis articulata (Vahl) Mast.	/	/	Protected in Algeria
Sedum acre L.	Quite rare	/	/
Cytisus triflorus L'Hér.	Rare	/	/
Ebenus pinnata Aiton	/	End. Alg.Mar Tun	/
Genista hirsuta subsp. *erioclada* (Spach) Raynaud.	End. Alg.Mar	Protected in Algeria	Quite rare
Hedysarum aculeolatum Munby ex Boiss.	/	End. Alg.Mar	/
Hedysarum pallidum Desf.	/	End. Alg.Mar Tun	/
Quercus faginea Lam.	Rare	/	/
Iris tingitana Boiss. & Reut.	/	End. Alg.Mar	/
Iris planifolia (Mill.) T. Durand & Schinz.	Quite rare	End. Alg.Mar Tun Lib	/
Iris unguicularis Poir.	/	End. Alg.Tun	/
Laurus nobilis L.	Very rare	/	/
Lamium purpureum L.	Rare	/	/
Nepeta multibracteata Desf.	Rare	/	/
Rosmarinus eriocalyx Jord. & Fourr.	/	/	/
Teucrium fruticans L.	Rare	/	/
Teucrium pollium L.	/	/	Protected in Algeria
Thymus algeriensis Boiss. & Reut.	/	End. Alg.Mar Tun Lib	/
Thymus ciliatus (Desf.) Benth.	Quite rare	End. Alg.Mar.	/
Thymus fontanesii Boiss. & Reut.= *T. pallescens de Noé.*	/	End. Alg.Mar	/
Thymus munbyanus subsp. *abylaeus* (Font Quer & Maire) Greuter & Burdet.	/	End. Mar	/
Thymus numidicus Poir.	/	End. Alg.Tun	/
Lythrum acutangulum Lag.	Quite rare	/	/
Phillyrea angustifolia L. subsp. *angustifolia*	Rare	/	/
Ophrys tenthredinifera Willd. subsp. *tenthredinifera.*	/	End. Alg.Mar Tun Lib	/
Anacamptis papilionacea (L.) R. M. Bateman, Pridgeon & M. W. Chase subsp. *papilionacea.*	Quite rare	End. Alg.Lib.	Protected in Algeria
Dactylorhiza elata (Poir.) Soó	Rare	/	NT (Almost threatened)
Cytinus hypocistis (L.) L.	Very rare	/	/
Clematis ammula L.	Very rare	/	/
Ranunculus macrophyllus Desf.	Rare	End. Alg.Mar	/
Ranunculus millefoliatus auct.=	Rare	End. Alg.Mar	/

Table 3. *Continued ...*

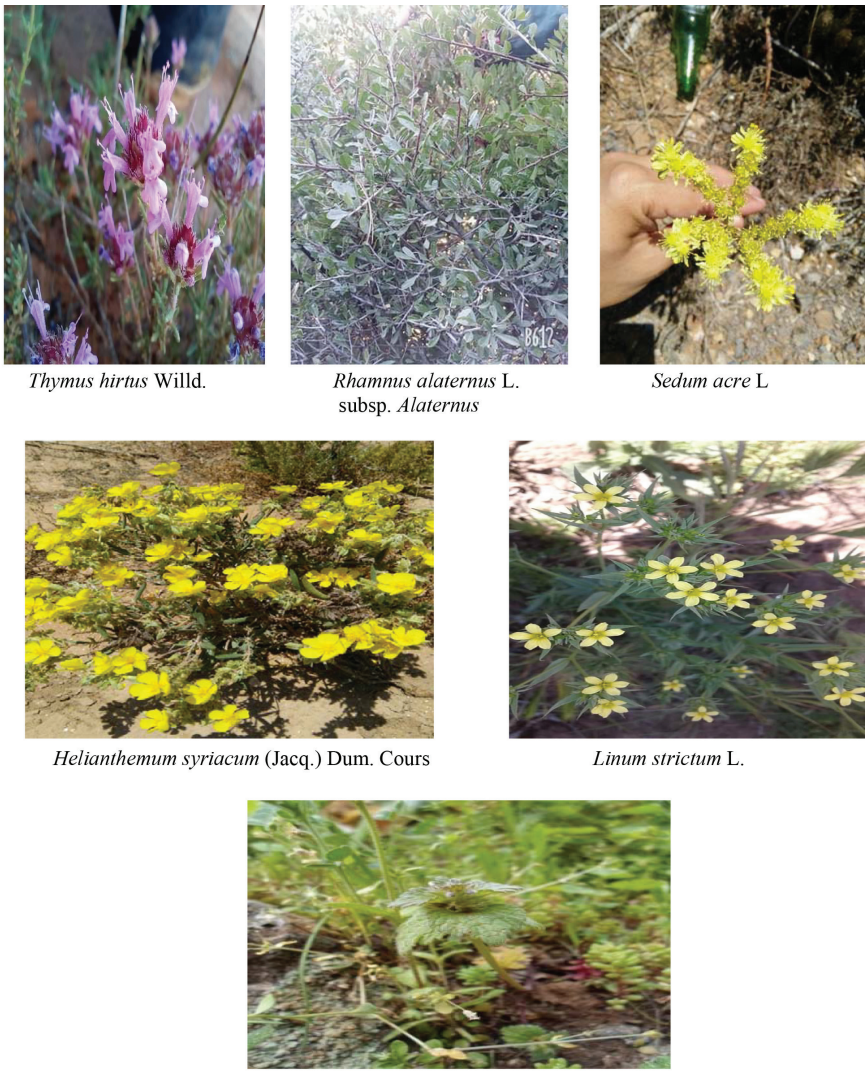
Taxa	Rare	Endemic	Protected
Ranunculus fibrosus Pomel.			
Rhamnus alternus L.	/	End. Alg.Mar Tun Lib.	/
Sanguisorba minor subsp. *vestita* (Pomel) Maire.	End. Alg.Mar Very rare	/	
Thymelae avirescens Meisn.	Very rare	End. Alg.Mar	/

Alg: Algerian, Mar: Moroccan does, **Tun**: Tunisian, **Lib**: Lybian, **N**: North.

tent that under multiple and permanent aggressions the plant cover is seriously threatened with extinction.

Our results are also in line with those obtained by Nasrallah and Kefifia (2015) in the Nesmoth area, located on the same mountain range, in Mascara city. These authors shown that forest stands are in poor condition and evidence of advanced forest degradation due to overgrazing, repeated fires, clearing, to inadequate forestry and exploitation and inadequate management.

In the same context, Barbero *et al*. (1990) report



Thymus hirtus Willd. | *Rhamnus alaternus* L. subsp. *Alaternus* | *Sedum acre* L

Helianthemum syriacum (Jacq.) Dum. Cours | *Linum strictum* L.

Planche 1. Rare, endemic, and protected taxes (phot. S.A. Aouadj).

that disturbances caused by man and his flocks are numerous and correspond to two increasingly severe situations ranging from matoralization to desertification going through steppisation.

Analysis of the net biological spectrum in our surveys shows that the rate of therophytes is very high by other biological types and shows that the importance of anthropogenic and climatic action in this forest, like all the forests in the area (Grime, 1977; Daget, 1980; Barbero *et al.*, 1990 and Dahmani, 1997). Hemicrypotophytes are the second most commonly found in moist (humid) habitats such as cliffs and riverine. According to Barbero *et al*. (2001), the abundance of hemicrypotophytes is related to the presence of moisture and organic matter. The Champhytes occupy the third position. Species of this type are characterized by good acclimatization to aridity by other biological types. Their high rate is a sign of ecosystem disruption and degradation (Danin and Orshan, 1990). Geophytes presents with a low rate. They are characterized by a low germination rate, which poses a real reproductive problem (Verlaque *et al*., 2001). The Phanerophytes occupy the penultimate place and herald a regressive dynamic of this ecosystem.

The Net Biological Spectrum of the study area is

Planche 2. Rare, endemic, and protected taxes (phot. S.A. Aouadj).

Table 4. Rare, endemic, and protected taxes not recorded by Djebbouri and Terras (2019).

Rare	Endemic	Protected
Clematis ammula L	*Rhamnus alternus* L	*Dactylorhiza elata* (Poir.) Soó
Sedum acre L	*Ranunculus millefoliatus* auct	*Anacamptis papilionacea* (L.) R. M. Bateman, Pridgeon & M. W. Chase subsp. *papilionacea*.
Crithmum maritimum L	*Sanguisorba minor* subsp. *vestita* (Pomel) Maire	*Teucrium pollium* L
Ranunculus millefoliatus auct	*Anacamptis papilionacea* (L.) R. M. Bateman, Pridgeon & M. W. Chase subsp. *papilionacea*.	*Biscutella cichoriifolia* Loisel
Sanguisorba minor subsp. *vestita* (Pomel) Maire	*Thymus numidicus* Poir	*Hieracium humile* Jacq
Cytinus hypocistis (L.) L	*Iris planifolia* (Mill.) T. Durand & Schinz	/
Dactylorhiza elata (Poir.) Soó	*Iris unguicularis* Poir	/
Anacamptis papilionacea (L.) R. M. Munby ex Boiss Bateman, Pridgeon & M. W. Chase subsp. *papilionacea*.	*Hedysarum aculeolatum*	/
Lythrum acutangulum Lag.	*Helianthemum croceum* (Desf.) Pers	/
Nepeta apuleii Ucria	*Rhamnus alaternus* L. subsp. *Alaternus*	/
Lamium purpureum L	*Thlaspi perfoliatum* L	/
Laurus nobilis L	*Hieracium humile* Jacq	/
Iris planifolia (Mill.) T. Durand & Schinz	*Hedera helix* L	/
Quercus faginea Lam	*Atractylis caespitosa* Desf	/
Lathyrus tingitanus L	/	/
Cytisus triflorus L'Hér	/	/
Helianthemum croceum (Desf.) Pers	/	/
Magydaris panacifolia (Vahl) Lange	/	/
Echium australe Lam	/	/
Echium confusum Coincy	/	/
Biscutella cichoriifolia Loisel	/	/
Carduncellus pinnatus (Desf.). DC	/	/
Asteriscus spinosus (L.) Sch. Bip	/	/
Atractylis caespitosa Desf	/	/

of type : Therophytes > Hemicryptophytes > Chaméphytes > Phanerophytes > Geophytes. The same biological type was obtained by Medjahdi *et al*. (2007); Letreuch-Belarouci *et al*. (2009); Medjahdi *et al*. (2009); Babali *et al*., (2014); Aouadj *et al.* (2018); Miara *et al.* (2018).

From a chorological point of view, the analysis showed a dominance of Mediterranean species (70%), the endemic type is in last position (7.26%) and wide-range types (Euro-Mediterranean, Eurasian, paleotemperate ... etc.) represented by 22.74%. This result is also, in accordance with those obtained by Braun-Blanquet *et al.* (1924) on the whole flora of North-Africain; Hasnaoui, (2008); Letreuch-Belarouci *et al*. (2009); Medjahdi *et al.* (2009) Babali e*t al*., (2014) on the flora of Tlemcen, Miara *et al*., (2018) on the flora of Tiaret.

Analysis of the results of the biodiversity indices shows an average value of (H'), this magnitude of 1.72 bits, indicates a fairly diverse environment (0 <H<5) as long as it does not theoretically have a maximum. In this regard, the calculated equitability value (E) is stronger, this size 2.53 bits, means that individuals of different species are more or less in balance.

A rarity rate of 31 taxa, representing 9.01% of the total flora of the study area and 1.7% of Algeria (1818 rare taxa) is quite important for an area located in semi-arid floor. This rate consists of 7 very rare species (VR), 16 rare species (R), and 8 fairly rare species (QR). The endemism rate is also high, with 25 taxa or 7.26% of the total flora of the study

area and 5.38% of Algeria (464 endemic taxa, of which 1 endemic taxon (Alg-Lib), 9 endemic taxa (Alg-Mar. Tun. Lib), 8 endemic taxa (Alg. Mar), 1 endemic taxon(Alg), 2 endemic taxons (Alg-Tun),1 endemic taxon (Mar) and 3 endemic taxons (Alg-Mar. Tun). The number of protected taxa is 9, or 2.32% of the total flora of the forest and 1.76% of Algeria (454 taxa protected). 8 taxa are protected in Algeria and 1 taxon almost threatened according to the status of The IUCN. These results open the door to the study of the establishment of a protected area (Table 3).

Comparison of our results with those advanced by Djebbouri and Terras (2019), allow to enrich the flora of this region by 43 other species (Table 4).

Conclusion

This work complements the publications made by the inventory of Djebbouri and Terras (2019) on the forest region of Saida. It is clear from this study, that the Doui Thebet area is quite diverse, with 1.72 bit Shannon-Wiener diversity indices, particularly by the presence of rare species, endemic and protected. These results open an opportunity to the study of the establishment of a protected area. However, that it also deteriorates due to human activities and change, which requires the development of emergency restoration and rehabilitation plans; which we will do in our research that we will conduct in our next publication.

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