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A RAMSAR WETLAND'S ENDEMIC FLORA INVENTORY AND CONSERVATION OF CHOTT EL HODNA'S PLANTS (NORTHEASTERN ALGERIA)

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Abstract

Chott El Hodna is classified as an internationally important site under the Ramsar Convention in Northeastern Algeria. It belongs to the Mediterranean arid bioclimatic zone. This area is an athalassic salt lake, with continental and dry climate. For the wetland operational management plan, it's necessary to know the endemic flora, its spatial distribution, and its conservation status. We used a non-probability mixed sampling type according to the environment. We worked in thirteen stations and each station was surveyed several times. The stations were situated on two opposite sites. We conducted in all 353 surveys and recorded 37 plant families, distributed in 139 genera, and 199 species. The most important family was Asteraceae. There were 34 endemic taxa in the wetland flora which belonged to 17 families, distributed over 31 genera. Their most important life form was therophyte. Therefore the species richness was mainly represented by annuals. The endemic flora mainly belonged to the Mediterranean region, a world center of plant diversity. Eighteen species showing this restricted distribution belonged to Mediterranean element. However, no taxon is on the UICN Red List. Territorial zoning, based on endemism and species richness was established for the conservation of flora.

Key words: Endemic flora, Repartition, Wetland, Richness, Conservation, Algeria.

Introduction

With only 2% of the world's terrestrial surface, Mediterranean ecoregions like Mediterranean Basin contain nearly 20% of the Earth's total plant diversity (Médail *et al*., 2019). Algeria situated in North Africa, belongs to the Mediterranean basin hotspot (Médail & Myers, 2004). Myers *et al*., (2000) considered that the Mediterranean countries had almost 4.5% of the world's endemic flora. Myers (1990) and Médail & Quézel (1999) showed that the Mediterranean region was one of the world's major centers of plant diversity, where 10% of higher plants could be found though representing only 1.6% of the Earth's surface. In fact the the most important biotic component of an ecosystem is the flora (Ozenda, 1982; Davis, 1996). The studied area, a wetland of international importance (Ramsar site) is an athalassic (inland) salt lake, having continental and dry climate. It is a part of the great watershed of Hodna (Hadjab, 1988; Mimoune, 1995; Le Houérou, 2009). This wetland is a salt pan. It is dry up in summer and sometimes re-flooded by water in the rainy season. It is formed by a Chott and a sebkha. Chott is the surrounding area that holds the vegetation. Sebkha is the central part dominated by water and devoid of vegetation due to presence of excessive salt.

Chott El Hodna is characterized by steppe vegetation (Le Houérou, 1995). It is dominated by salt-tolerant, perennial, casulescent species (Kaabeche *et al*., 1995), and annuals (Zedam, 2015). Kaabeche (1990) noted that the study region biogeographically belonged to the Mediterranean region with two sub-regions: Eu-Mediterranean and Saharo-Arabian.

For the management and conservation of natural environments and especially of Ramsar wetland, floristic data is needed, particularly endemics or rare species reflect the importance of the local or the regional biodiversity and gives an identity to the region (Zohary, 1973; Zedam & Fenni, 2015). The precise knowledge of the regional vegetation is the essential foundation and the starting point for the conservation of the flora (Quézel, 1991). The inventorising the endemic plants of our study area having an international importance, was necessary to know the overall composition of the existing taxa, floral diversity and chorology species because this area belonged to a wetland and must be preserved (Zedam &Fenni, 2015).

Material and Method

Study area: Chott El Hodna is located in Northeastern Algeria (Fig. 1). It is one of the largest Chotts with an area of 3620 km². It was declared a Ramsar site of international importance in 2001 (Anon., 2002).

According to the weather data from the nearest meteorological stations, the study area belongs to the Mediterranean arid bioclimatic stage with a mild winter (Q_2 = 17.02 – 19.84, m = 3.37 to 4.10°C, M = 38.87 to 40.06°C, P = 182.94 to 201.86 mm). The seasonal rainfall regime is Autumn-Spring–Winter-Summer. The Mediterranean climate of the region is subjected to the influence of the Sahara (Mimeche *et al*., 2103). Geologically Chott El Hodna is a transito-accumulative landscape of quaternary alluvial deposits (Pouget, 1980), where its relief is flat and sometimes undulating. It is characterized by a depression (Hodna depression), which has two distinct zones: sebkha and chott, and the altitude of this wetland varies between 392 to 400 meters. The Chott and sebkha soils are sub-desert clayey zone (heavy soil texture). They are very strongly to excessively saline (Le Houérou *et al*., 1975) and partly bordered by raw mineral soils (Le Houérou, 1995). Hydrologically, this environment is related to the rainfall regime, which is characterized by strong irregularities. The majority of watercourses do not have permanent flows (Mimoune, 1995).

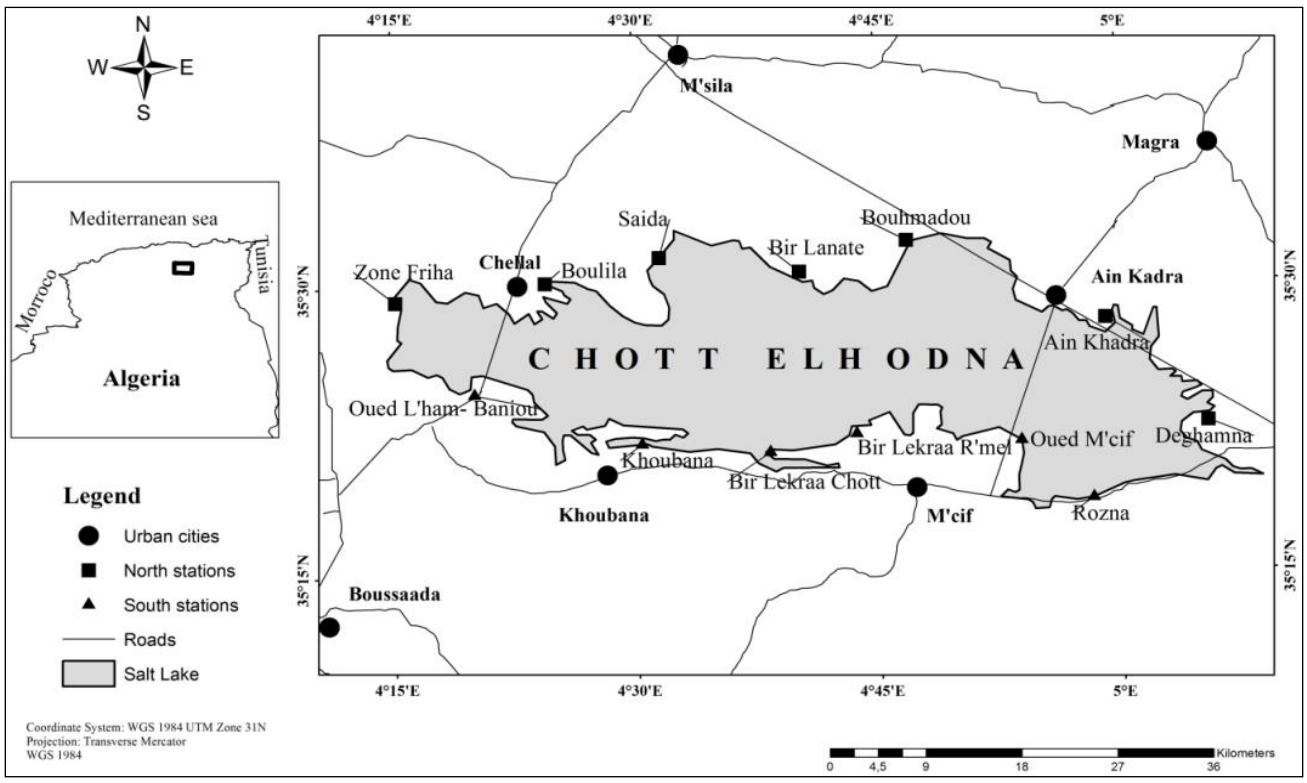

Fig. 1. Study area of Chott El Hodna wetland.

Vegetation description: According to Géhu *et al*., (1993) and Kaabeche (1995), Chott El Hodna's vegetation is a particular steppe. It is characterized by certain arid formations of North Africa.

These are grassy more or less shrubby communities dominated by grasses (alfa) or chamephytes (mugwort, remth) but also with an irregular presence of annual species (therophytes). This gives different structures and distinct phenologies. There are two physiognomic types: The first is permanent, based on perennials and the second is temporary, dominated by therophytes.

These plant formations are low (less than 1m), and the coverage rarely exceeds 50%, and according to the climatic and the edaphic conditions and their distribution, two large formations occur:

Steppes controlled factors: steppes dominated with alfa (*Macrochloatenacissima* (L.) Kunth) or with sagebrush (*Artemisia herba-alba*Asso. and *Artemisia campestris* L.), steppe with sparta (*Lygeumspartum* Loefl. ex L.), and steppe with remth (*Haloxylon scoparium* Pomel).

Steppes controlled by edaphic factors, linked either with soil texture: sandy steppe (*Stipagrostis pungens* (Desf.) De Winter) or linked with the soil chemistry: halophilic steppe (*Salicornia arabica* L.).

Sampling and data analysis: The aim of our study is to prepare an inventory of the wetland's endemic flora and trace its spatial distribution for eventual conservation or future preservation operation. Our study was conducted by non-probability mixed sampling. This sampling included both subjective and systematic sampling according to the characteristics of the type of the four study physiographic conditions: Wadi Banks, Dune Zone (R'mel), Land overlooking the sebkha (Raised ground), and Chott.

The surveys were conducted during the spring seasons, from March 2014 to May 2018. We used the Braun-Blanquet minimum area method (Guinochet, 1973), where Hammada (2007) also employed it in the study of Morocco's wetlands vegetation. Each inventoried plant species in this well-defined area was assigned by a semi-quantitative coefficient: abundance dominance (Gillet, 2000). The distance between surveys varied from 100 to 180 meters, and the survey area ranged from 20 to 70 m². The stations were situated to two opposite sites: one in the north and the other in the south.

The collected specimens were identified and determined using the Flora of North Africa: Maire (1952; 1987), New flora of Algeria and southerly desert regions: Quézel & Santa (1962; 1963), Flora of the Sahara: Ozenda (2004), Synonymic index of the North Africa flora: Dobignard & Chatelain (2010-2013) and the database «Euro+MedPlantbase» available at www.emplantbase.org. The nomenclature of taxa refers to the International Plant Names Index (Anon., 2020) available at: http://www.ipni.org.

In case of Ramsar wetland's endemic flora, case of Chott El Hodna, we considered that when considered as Algerian endemic according to Véla & Benhouhou (2007) was specified as "endemic" (noted "End"), it was considered as an Algerian endemic according to Véla & Benhouhou (2007). Quézel & Santa (1962; 1963) classified the abundance or the rarity of flora into eight levels ranging from "extremely rare" (RRR) to "extremely common" (CCC). Véla & Benhouhou (2007) noted that these categories were subjective based on the evaluations of the authors. Therefore in our analysis of this index, we used

only three levels of rarity: very rare: "RR", rare: "R" and quite rare: "AR" (Véla & Benhouhou, 2007; Medjahdi, 2010; Zedam & Fenni, 2015; Zedam, 2015). Concerning the biological types, we used those of Raunkiaer (Lahondère, 1997), where the types were determined as they appeared on the land (Emberger, 1966).

An overview of the total flora of Chott El Hodnaalongwith the presentation of the endemic flora (taxonomy-chorology, rarity-endangered taxa, and biological types) is presented. Regarding the distribution and the conservation of the existing flora, entire flora was taken into consideration without any distinction of the endemic flora.

Data analysis focused on: (i) The handling of the floristic surveys and taxa of this saline and dry lake was made by Excel for Windows 2007 Software, (ii) Distribution of endemic flora and plant richness for their conservation using ArcGIS program-Version 10.2 (ESRI).

Results

Total flora: The total number of floristic surveys was 353, conducted in thirteen (13) stations: 7 belonged to the North site and 6 to the South one (Table 1).

In all 199 species were recorded, distributed in 138 genera and 37 families. All the species belonged to Angiospermic group except one taxon: *Ephedra alata* Decne a Gymnosperm. The Liliopsida Class was represented by 4 families, having 29 genera and 35 species.

MagnoliopsidaClass was represented by 109 genera with 163 species which, was more than 80% of the total inventoried flora. The most important families were Asteraceae, Poaceae, Fabaceae, Amaranthaceae, Brassicaceae, Caryophyllaceae, and Apiaceae with respectively a number of Species/Genera of 30/23, 29/23, 23/12, 22/15, 14/12, 8/6 and 7/6 number of species/ genera respectively. Biogeographically, the Mediterranean origins in its larger sense is the most represented one followed by the Saharan origins. The dominant life form of the study area was the therophyte with 118 species representing 59.30% of the total flora. The other biological types were represented by: chamaephyte 39 species (19.60%), hemicryptophyte 20 species (10.05%), geophyte 14 species (07.04%), and phanerophyte 08 species (04.02%).

The total flora's rarity of Chott El Hodna is 73 species distributed as follows: quite rare (15 species), very rare (18 species), and rare (40 species).

Endemic flora overview

Taxonomy and chorology: According to Quézel & Santa (1962; 1963), Ozenda (2004), and Dobignard & Chatelain (2010; 2013), there are 34 endemic taxa in wetland's vegetation representing 17.08% of the total number of species found in the area. These species belonged to 17 families, distributed over 31 genera (Table 2).

Rare and endangered taxa: The rarity of endemic 18 species is divided into:
Quite rare "AR" : 7 species belonged to this category: *G. saharae*, *A. cinereum*, *A. obtusa*, *P. teretifolia*, *C. violacea*, *L. cymuliferum*, and *D. biseriatus.*
Rare "R" : 7 species belonged to this category: *E. dracunculoides* subsp. *flamandi*, *L. pruinosum*, *L. guyonianum*, *D. pitardiana*, *S. carnosa*, *T. africanus*, and *E. fruticosum.*
Very rare "RR": This category was represented by 4 species: *A. armatus*, *M. macrocarpus*, *S. saturejoides*, and *L. laxiflora*.

Biological types: There were five (05) biological types (life form) for the endemic species, which were: therophyte (15 species), chamaephyte (10 species), hemicryptophyte (04 species), phanerophyte (03 species), and geophyte (02 species). The dominant life form was therophyte, and it represented 44% of the endemic species; followed by chamaephyte with 29%. The hemicryptophyte, phanerophyte, and geophyte were 12%, 09%, and 06% of the total inventoried endemic plants respectively.

Table 1. Distribution of floristic surveys.

Sites		Stations	Surveys number	Plant richness	Number of endemic plants
South	1	OuedLham-Baniou	42	87	17
	2	Khobana	35	85	13
	3	BirLekraaChott	27	54	10
	4	BirLekraaR'mel	18	48	10
	5	OuedM'cif	42	67	6
	6	Rozna	25	57	9
		Total 1	189	165	31
North	1	Deghamna	22	64	9
	2	AinKhadra	32	69	9
	3	Bouhmadou	13	27	4
	4	BirLanate	25	47	5
	5	Saida	29	69	8
	6	Boulila	20	31	4
	7	Zone Friha	17	12	0
		Total 2	164	135	16
		Total (1+2)	353	199*	34*

(*): the total doesn't mean the sum.

Table 2. Chott El Hodna wetland's endemic taxa.

Species	Families	Chorological origin (endemism)	Biological types (*)	Rarity
Astragalus gombo Coss. & Durieu ex Bunge	Fabaceae	North Saharan	Thero.	
Euphorbia dracunculoide subsp. Flamandii (Batt.) Maire	Euphorbiaceae	Saharan	Chamaep.	R
Euphorbia guyoniana Boiss. &Reut.	Euphorbiaceae	Saharan	Chamaep.	
Scrophularia syriaca Benth.	Scrophulariaceae	Saharan	Chamaep.	
Lycium shawii Roem. &Schult	Solanaceae	Saharan	Phaner.	
Genista saharae Coss. & Durieu	Fabaceae	Saharan	Phaner.	AR
Ammosperma cinereum (Desf.) Baill.	Brassicaceae	Saharan	Thero.	AR
Limonium pruinosum (L.) Chaz.	Plumbaginaceae	Saharan	Hemicry.	R
Aristida obtuse Delile	Poaceae	Saharan	Hemicry.	AR
Pseuderucaria teretifolia (Desf.) O.E. Schulz	Brassicaceae	North African	Thero.	AR
Thymelaea microphylla Coss. & Durieu	Thymeleaceae	North African	Chamaep.	
Limoniastrum guyonianum Durieu ex Boiss.	Plumbaginaceae	North African	Phaner.	R
Frankenia thymifolia Desf.	Frankeniaceae	North African	Chamaep.	
Astragalus armatus Willd.	Fabaceae	North African	Chamaep.	RR
Melilotus macrocarpus Coss. et Durieu	Fabaceae	North African	Thero.	RR
Deverra battandieri (Maire) Podlech	Apiaceae	North African	Geophy.	
Enarthrocarpus clavatus Delile ex Godr.	Brassicaceae	North African	Thero.	
Anacyclus monanthos subsp.*cyrtolepidioides* (Pomel) Hum.	Asteraceae	North African	Thero.	
Rhanterium suaveolens Desf.	Asteraceae	North African	Chamaep.	
Cistanche violacea (Desf.) Hoffmanns. & Link	Orobanchaceae	North African	Thero.	AR
Hypecoum littorale Wulfen	Papaveraceae	North African	Thero.	
Anthemis monilicostata Pomel	Asteraceae	Alg-Moroccan	Thero.	
Diplotaxis pitardiana Maire	Brassicaceae	South Moroccan	Thero.	R
Sulla carnosa (Desf.) B.H. Choi & H. Ohashi	Fabaceae	Alg -Tunisian	Thero.	R
Tetraena cornuta Coss. Beier & Thulin	Zygophyllaceae	Alg -Tunisian	Chamaep.	
Limonium cymuliferum (Boiss.) Sauvage & Vindt.	Plumbaginaceae	Algerian	Hemicry.	AR
Silene arenarioides Desf.	Caryophyllaceae	Algerian	Thero.	
Spergularia munbyana Pomel	Caryophyllaceae	Algerian	Geophy.	
Saccocalyx saturejoides Coss. & Durieu	Lamiaceae	Algerian	Chamaep.	RR
Herniaria mauritanica Murb.	Caryophyllaceae	Algerian	Thero.	
Tripogon africanus (Coss. & Durieu) H. Scholz & P. König	Poaceae	Algerian	Hemicry.	R
Linaria laxiflora Desf.	Scrophulariaceae	Algerian	Thero.	RR
Echiochilon fruticosum Desf.	Boraginaceae	Algerian	Chamaep.	R
Daucus biseriatus Murb.	Apiaceae	Algerian	Thero.	AR

(*)/ Thero.: Therophyte, Chamaep.: Chamaephyte, Hemicry.: Hemicryptophyte, Phaner.: Phanerophyte, Geophy.: Geophyte

Discussion

About 37 families were reported from Chott El Hodna. The most abundant ones were Asteraceae, Poaceae, Fabaceae, Amaranthaceae, Brassicaceae, Caryophyllaceae, and Apiaceae. They represented more than 66% of the inventoried species and 69, 56% genera. In this context, it was necessary to note that 13 families were represented by single taxon and 4 families by two taxa (Magurran, 2004; 2005). The proportional distribution of taxa within families and their importance in Chott El Hodna flora were discussed by Zedam (2015). In the Algerian flora, Quézel (1964) also reported that the most families were Asteraceae, Caryophyllaceae, Fabaceae, Brassicaceae, Apiaceae, and Poaceae.

The presence of Amaranthaceae (ex-Chenopodiaceae) in this study was an indication of a special biotope. Indeed, Emery-Barbier (1988); Koull & Chehma (2013) indicated that many species of this family were halophytes and locally bound the arid and saline substrate as our study area.

Due to the geographic location of the study area between the Mediterranean sea in the north and the Saharan desert in the south, the species chorology of Chott El Hodna flora showed that the Mediterranean origins were the most dominant ones with more than 63% followed by those related to the Saharan chorological origins with 17.59%. The cosmopolitan species represented 6%, and the remaining taxa accounted for almost 12.56% of all the reported chorological ones. This biogeographical diversity was due to the plant requirements and their history, which was related to the Mediterranean basin hotspot, and belonged to the world's Mediterranean eco-regions which represented about 20% of the total plant diversity of the Earth (Médail *et al*., 2019) though it only had 2% of the world's land surface.

The dominant life form in this study was the therophyte, represented by 118 species of the total flora. The other biological types were represented, with a total of 81 taxa.

The three levels of rarity were related to 73 taxa (36.68%) of the total flora. This rarity gives an ecological value and floristic importance for a natural region (Fennane, 2004), especially for a wetland.

Concerning the endemic flora, Fennane (2004) mentioned the ecological value of the endemic plants for a floristic region. The dominant families of the endemic flora in our study area were Fabaceae with 05 taxa, Brassicaceae

with 04 taxa, and Asteraceae, Caryophyllaceae, and Plumbaginaceae with 03 taxa each. The remaining 12 families were represented by 1 or 2 species (Magurran, 2004; 2005). The chorological origin of this endemic flora are North African (12 taxa), north Saharan and Saharan (09 taxa), Algerian (09 taxa), Algerian-Tunisian (02 taxa), Algerian-Moroccan (01 taxon), and South Morocco (01 taxon). Except for the Saharan chorological origins, the remaining origins (over 76% of the endemic flora) belonged to the Mediterranean region which is a world center of plant diversity (Médail & Quézel, 1999; Médail & Myers, 2004).

The 18 rare species of endemic flora are not reported on the IUCN Red List, but the national legislation in Algeria reveals that there are six taxa, two of them are endemic in our study area, and they are nationally protected by Executive Decree No. 12-03 of January 4, 2012. The list of the protected uncultivated plant species:

Helianthemum lippii (L.) Dum. Cours. (Cistaceae)
Ononis natrix L (Fabaceae)
Centaurea microcarpa Coss. & Durieu ex Batt. & Trab. (Asteraceae)
Ephedra alata Decne. (Ephedraceae)
G. saharae (Fabaceae)
S. saturejoides (Lamiaceae)

In all the inventoried endemic species there were five (05) life forms of Chott El Hodna. The dominant one was therophyte. This life form reflects the suitability of seasonal habitats of the study area for rapid annual germination and fast growth of annuals "therophytes" (Hammada *et al*., 2004). In the same way, Zedam (2015) has mentioned a similar state. The same dominant life form in the terrestrial flora was also reported from Morocco's wetlands (Hammada *et al*., 2004; Hammada, 2007). At Chott El Hodna territory, this kind of flora belonged to the steppe formation where the therophytes were abundant compared to the other life forms (Kaabeche, 1990; Kaabeche, 1995; Khaznadar *et al*., 2009). The variety of our study environments makes the plant richness most important due to the geomorphology of the region which created a wide range of local climates (Médail & Myers, 2004) in relation to the requirements of the plants. On the other hand, the presence of the chamaephyte with 29% of the endemic species showed the particular vegetation of the study area where Negadi *et al*., (2014) reported that chamaephytization (abundance of Chamaephytes) appeared to be related to the anthropogenic degradation of the environment, with the proliferation of the thorny-species found in our study area (*A. armatus*). Also a non-endemic species of Hemicryptophyte became in this environment as thorny bush like *Phragmites communis* Trin which was earlier reported by Ozenda (2004).

To establish distribution of flora and to propose a strategy for its conservation, it is essential to specify the importance of endemism and the areas of endemism, reflected in the areas important for conservation (Noroozi *et al*., 2019). The inventorizing of endemic species in a region is a first step to assess the conservation situation of that region (Noroozi *et al*., 2019). Whittaker *et al*., (2005) also reported that the areas with high endemism values were designated as priority areas for conservation. Many methods and attempts are used to conserve biodiversity such as species richness, endemism, endangered species, representative ecosystem, or a combination of these factors (Hou *et al*., 2010). In our study, the distribution of the endemic species is not the same among the stations as shown in table 1. The endemic taxa reflect areas of species richness and their particular ecology, so they must be studied together, and it cannot be dissociated. We identified 04 kinds of endemism referring to the local existing richness (Fig. 2).

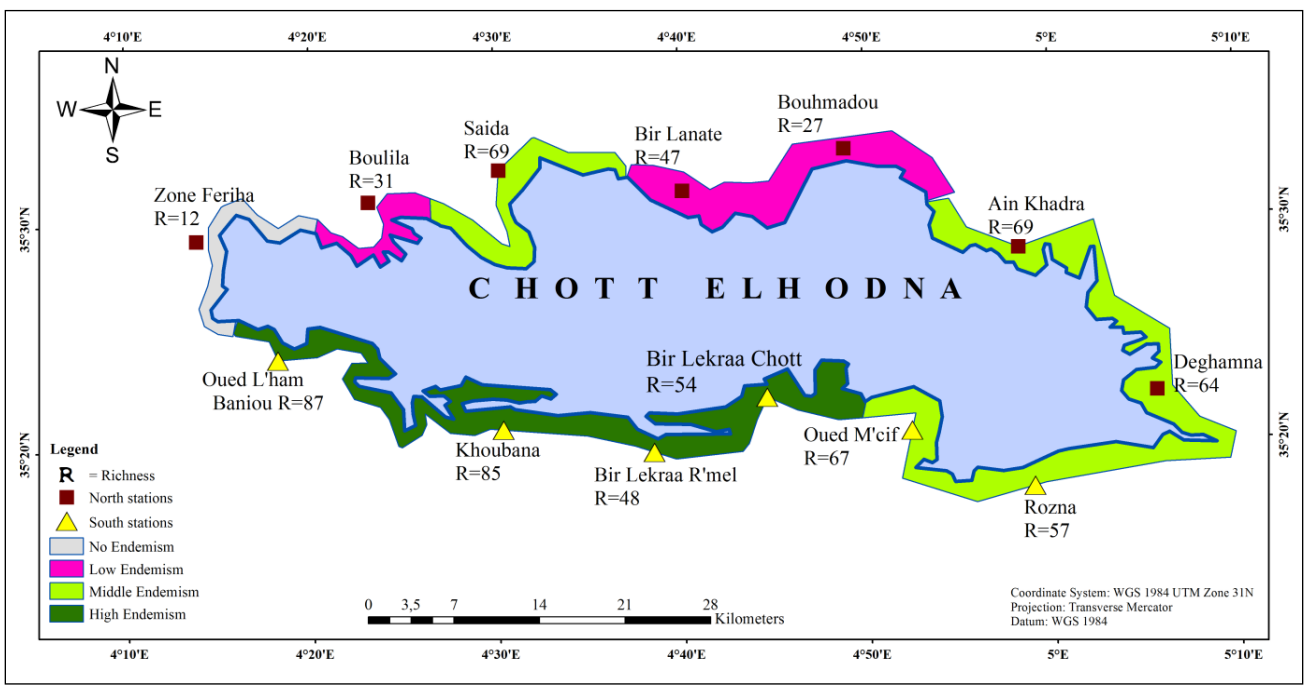

Fig. 2. Endemism and plant richness at Chott El Hodna wetland.

The endemism inventoried in the studied wetland can be summarized in 4 types:

1. High endemism: was found in four stations of the south site: OuedLham-Baniou, Khobana, BirLekraaChott, and BirLekraaR'mel. The mean value of this endemism was 12.50 species.
2. Middle endemism: was inventoried in two stations of the south site: OuedM'cif and Rozna and three stations at the north one: Deghamna, AinKhadra, and Saida. The mean of the endemism was 08.20 species.
3. Low endemism: was reported in three stations of the north site: Bouhmadou, BirLanate, and Boulila. The mean of the endemism was 04.33 species.
4. No endemism: was observed in only one investigated station of the north site: Zone Friha.

Moreira-Munoz *et al*., (2013) opined that the species richness and endemism could be found in particular regions rather than others. In this context, Zedam (2015); Zedam & Fenni (2015) reported that the south site seemed richer than the north. Because of its biotopes and its favorable ecological conditions, it could play an important role locally.

For the conservation of natural populations of plants *in situ* conservation is the surest way as it does not lose the evolutionary potential of species (Holsinger, 1992) compared to *ex situ* conservation which would only conserve backup copies (Delanoe *et al*., 1996). Sergio & Pedrini (2007) also denoted that biodiversity conservation was traditionally done by simply conserving species, but it is replaced by the conservation of biodiversity sites where preservation is more efficient, which will give protected areas welcoming and unmodified environments.

There is no operational management plan for the wetland of Chott El Hodna, which contained 34 endemic species with 18 quite rare to very rare species and an inventory of 199 taxa. Therefore, we propose 3 types of management for sustainability of the phytodiversity at Chott El Hodna: biodiversity management, agricultural practices management, and biotope management.

It is also important to indicate that this conservation must be done by conserving the entire found flora richness, and not just the conserving the part of the existing flora.

Biodiversity: Areas with high biological potential must be well delimited by a zoning, which must be carried out. In our case, the South site has priority over the North site due to the specific richness and significant local endemism: the OuedLham-Baniou station has priority over the BirLanate station (Fig. 2).

By taking into account the total floristic richness and by considering the presence of endemism (Hou *et al*., 2010) in our study area, the zoning areas coincided with the location of the endemism's kinds as identified in Fig. 2.

High flora richness zone: where conservation interventions are important because it is considered like a local "hot spot" that can promote the bordering zones. It includes the stations: OuedLham-Baniou, Koubana, Bir Lekraa Chott, and BirLekraaR'mel.

Middle floristic richness zone: where the interventions of the preservation are moderate. It contains the stations: Saida, Deghamna, AinKhadra, Rozna, and OuedM'cif.

Low floristic richness zone: where conservation interventions are limited (the natural environment is not rich in species). It includes the stations of BirLanate, Bouhmadou, and Boulila.

Very low floristic richness zone: where conservation interventions are very limited (the natural environment is very poor in species). It represents the only station of Zone Friha.

Agricultural practices: Agricultural practices are summed up in crop rotation, cultivation plan, respect of the animal load, nomadic practice, and land allocation Soulé (1991) points out that land uses have been identified as the major and the only cause of biodiversity loss in recent years.

Biotope: Maintaining an environment in balance implies its preservation. Environmental management aimed to multiply already existing ecological niches especially in the southern site where three different environments are juxtaposed. This approach will certainly lead to a biocenotic development and a certain balance.

Conclusion

The studied area, Ramsar site, is an athalassic salt lake, continental and dry. It is situated in northeastern Algeria. It has a steppe vegetation. It harbors particular kind of flora that is adapted to the physiography or relief of the area: wadi banks, dune zone, raised ground, and Chott. The floristic richness is dominated by salt-tolerant, perennial, succulent species and annuals. In our study case, if we consider the total flora, we find that the Asteraceae family dominates in all the 37 families present, and if endemic flora is taken into consideration Fabaceae family is the most dominant. The endemic flora belongs chronologically to the Mediterranean region which is one of the world's important centers of plant diversity and where it integrates its hotspot. These endemic and rare species are not included in the IUCN Red List, but the national legislation in Algeria reveals that six taxa are protected. The dominance of the life form of therophyte makes the study area as seasonally suitable habitats for the development of rapid annual germination and fast growth. The presence of the chamaephyte shows that this particular vegetation is related to the anthropogenic degradation of the habitat. For conservation management of biodiversity, agricultural practices and biotope we must take into consideration the total floristic richness and the endemic flora. The particular ecology of our wetland reveals its floral richness and its particular endemism, for an operational management plan, biodiversity management, agricultural practice and biotype must be included on emergency basis to guarantee its sustainability.

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References

Anonymous. 2002. Atlas des 26 zones humides algériennes d'importance internationale. Atlas 3. Direction Générale des Forêts (DGF), Alger.

Anonymous. 2020.International Plant Names Index.Published on the Internet: http://www.ipni.org, The Royal Botanic Gardens, Kew, Harvard University Herbaria & Libraries and Australian National Botanic Gardens.[Retrieved 05 June 2020].

Davis, T.J. 1996. Le Manuel de la Convention RAMSAR. In*:* (Ed.): Davis, T.J. Bureau de la Convention RAMSAR de Suisse.

Delanoe, O., B. De Montmollin and L. Olivier. 1996. Conservation of Mediterranean Island Plants.1. Strategy for action. IUCN/SSC Mediterranean Islands Plant Specialist Group. Gland, Switzerland and Cambridge, UK.

Dobignard, A. and C. Chatelain. 2010-2013. Index synonymique et bibliographique de la flore d'Afrique du Nord.Vol. 1,2 ,3 ,4 et 5. C.J.B.G, Genève.

Emberger, L. 1966. Réflexions sur le spectre biologique de Raunkiaer. *Bulletin de la Société Botanique de France*, 113(2): 147-156.

Emery-Barbier, A. 1988. Analyses polliniques du Quaternaire supérieur en Jordanie méridionale. *Paléorient*, 14(1): 111-118.

Fennane, M. 2004. Propositions de Zones Importantes pour les Plantes au Maroc (ZIP Maroc). Atelier National sur les Zones Importantes de Plantes au Maroc. Octobre, 11-12 2004. Rabat, Maroc: 25.

Géhu, J.M., M. Kaabeche et R. Gharzouli. 1993. Une remarquable toposéquencephytocoenotique en bordure du Chott El Hodna (Algérie). *Fragm. Flor. Geobot*., Suppl. 2(2): 513-520.

Gillet, F. 2000. La phytosociologie synusiale intégrée – Guide méthodologique. Université de Neuchâtel (France).Documents du Laboratoire d'écologie végétale. France.

Guinochet, M. 1973. Phytosociologie. Ed. Masson et Cie. Paris.

Hadjab, M. 1998. Aménagement et protection des milieux naturels dans la cuvette centrale du Hodna (Algérie). Ph.D. Thesis. Université d'Aix Marseille1, France.

Hammada, S. 2007. Études sur la végétation des zones hmides du Maroc-Catalogue et Analyse de la Biodiversité floristique et d'identification des principaux Groupements Végétaux. Ph.D. Thesis. Université Mohammed V, Rabat, Maroc.

Hammada, S., M. Dakki, M. Ibn Tattou, A. Ouyahya and M. Fennane. 2004. Analyse de la biodiversité floristique des zones humides du Maroc. Flore rare, menacée et halophile. *Acta Bot.Malacitana*, 29: 43-66.

Holsinger, K.E. 1992. Setting priorities for regional plant conservation programs.*Rhodora*, 94: 243-257.

Hou, M.F., J. López-Pujol, H.N. Qin, L.S. Wang and Y. Liu.2010. Distribution pattern and conservation priorities for vascular plants in Southern China: Guangxi Province as a case study. *Bot. Studies*, 51: 377-386.

Kaabeche, M. 1990. Les groupements végétaux de la région de Bou Saada (Algérie) Essai de synthèse sur la végétation steppique du Maghreb. Ph.D. Thesis. Université de Paris-Sud Centre d'Orsay.

Kaabeche, M. 1995. Flore et végétation dans le Chott El Hodna (Algérie). *Documents phytosociologiques*, 15: 394-402.

Kaabeche, M., R. Gharzouli and J.M. Gehu. 1995. Observations phytosociologiques sur le Tell et les Hautes Plaines de Sétif (Algérie). *Documents Phytosociologiques*, 15: 117-125.

Khaznadar, M., I.N. Vogiatzakis and G.H. Griffiths. 2009. Land degradation and vegetation distribution in Chott El Beida wetland, Algeria.*J. Arid Environ.*, 73: 369-377.

Koull, N. and A. Chehma. 2013. Diversité floristique des zones humides de la Vallée de l'Oued Righ, (Sahara septentrional algérien). *Revue des Bio-Ressour.*, 3(2): 72-81.

Lahondère, C. 1997. Initiation à la phytosociologie sigmatiste. *Bulletin de la Société Botanique du Centre-Ouest*, 16: 47.

Le Houérou, H.N. 1995. Bioclimatologie et biogéographie des steppes arides du Nord de l'Afrique: diversité biologique, développement durable et désertisation.*CIHEAM -Options Méditerranéennes: Série B, Etudes et Recherches*, 10: 1-396.

Le Houérou, H.N. 2009. Bioclimatology and biogeography of Africa.Springer. Verlag Berlin Heidelberg.

Le Houérou, H.N., J. Claudin, N. Haywood and J. Donadieu. 1975. Etudes des ressources naturelles et expérimentation et démonstration agricoles dans la région du Hodna, Algérie. Etude phytoécologique du Hodna, *Volume 1*. PNUD-FAO. Rome.

Magurran, A.E. 2004. Measuring Biological Diversity. Blackwell Publishing Company.Malden.

Magurran, A.E. 2005. Species abundance distributions: pattern or process?.*Fun. Ecol. Forum*, 19: 177-181.

Maire, R. 1952-1987. Flore de l'Afrique du Nord. Ed. Paule Lechevalier. Paris.

Médail, F. and N. Myers. 2004. Mediterranean Basin. In*:* Fonseca, D.A., G.A.B. (Ed.): Hotspots revisited: Earth's biologically richest and most endangered terrestrial ecoregions.: 144-147. CEMEX (Monterrey), Conservation International, (Washington) &Agrupación Sierra Madre, Mexico.

Médail, F. and P. Quézel.1999. Biodiversity Hotspots in the Mediterranean Basin: Setting Global Conservation Priorities.*Cons. Biol.*, 13(6): 1510-1513.

Médail, F., A.C. Monnet, D. Pavon, T. Nikolic, P. Dimopoulos, G. Bacchetta, J. Arroyo, Z. Barina, M.C. Albassatneh, G. Domina, B. Fady, V. Matevski, S. Mifsud and A. Leriche. 2019. What is a tree in the Mediterranean Basin hotspot? A criticalanalysis. *Forest Ecosys.*, 6: 17, 1-19.

Medjahdi, B. 2010. Réponse de la végétation du littoral oranais aux perturbations: Cas des monts des Trara (Nord-Ouest de l'Algérie). Ph.D. Thesis. Université de Tlemcen, Algérie.

Mimeche, F., M. Biche, A. Ruiz-Navarro and F.J. Oliva-Paterna. 2013. The population structure, age and growth of *Luciobarbus callensis* (Cyprinidae) in a man-made lake in the Maghreb (NE Algeria). *Limnetica*, 32(2): 391-404.

Mimoune, S. 1995. Gestion des sols salés et désertification dans une cuvette endoréique d'Algérie (Sud du Chott El Hodna). Ph.D. Thesis. Université de. D'Aix-Marseille, France.

Moreira-Munoz, A., S. ElorteguiFrancioli, C. Hobohm and M.P.S. Menezes De Sequeira. 2013. Endemism on Islands – Case Studies. In: (Ed.): Hobohm, C. *Endemism in Vascular Plants.* Springer, Germany, pp. 165-204.

Myers, N. 1990.The Biodiversity Challenge: Expanded Hot-Spots Analysis.*The Environ.*, 10(4): 243-256.

Myers, N., R.A. Mittermeier, C.G. Mittermeier G.A.B. Da Fonseca and J. Kent. 2000. Biodiversity hotspots for conservation priorities. *Nature*, 403(6772): 853.

Negadi, M., A. Hassani, F. Bounacuer and M.E. Azzaoui. 2014. Etude de la diversité floristique de la région d'El Bayadh (Algérie): Flore rare et menacée. Revue Ecologie-Environnement, Université de Tiaret – Algérie, 10: 50-55.

Noroozi, J., G. Zare, M. Sherafati, M. Mahmoodi, D. Moser, Z. Asgarpour and G.M. Schneeweiss. 2019. Patterns of endemism in Turkey, the meeting point of three global biodiversity hotspots, based on three diverse families of vascular plants. *Front. in Ecol. & Evol.*, 7: 1-12.

Ozenda, P. 1982. Les Végétaux dans la biosphère. Doin Ed., Paris.

Ozenda, P. 2004. Flore du Sahara. CNRS editions, Paris.

Pouget, M. 1980. Les relations sol-végétation dans les steppes sud-algéroises. Travaux et document de l'O.R.S.T.O.M. Paris.

Quézel, P. 1964. L'endémisme dans la flore de l'Algérie. *Compte rendu sommairedes* séances *de la Société de biogéographie*, 361: 137-149.

Quézel, P. 1991. Structures de végétation et flore en Afrique du Nord: Leurs incidences sur les problèmes de conservation. In: (Eds.): Rejdaliet, M., V.H. Heywood, Conservation des ressourcesvégétales, p. 19-32. Actes Editions, Institutagronomiqueetvétérinaire Hassan II, Rabat, Maroc.

Quézel, P. and A. Santa. 1962. Nouvelle Flore de l'Algérie et des régions désertiques méridionales. CNRS, Paris.

Quézel, P. and A. Santa. 1963. Nouvelle Flore de l'Algérie et des régions désertiques meridionales. CNRS, Paris.

Sergio, F. and P. Pedrini. 2007. Biodiversity gradients in the Alps: the overriding importance of elevation. *Biodiversity & Conser.*, 16: 3243-3254.

Soulé, M.E. 1991. Conservation: Tactics for a Constant Crisis.*Science*, 253(5021): 744-750.

Véla, E. and S. Benhouhou. 2007. Évaluation d'un nouveau point chaud de biodiversité végétale dans le bassin méditerranéen (Afrique du nord). *Comp.Rendus Biol.*, 330(8): 589-605.

Whittaker, R.J., M.B. Araújo, P. Jepson, R.J. Ladle, J.E.M. Watson and K.J. Willis.2005. Conservation Biogeography: assessment and prospect. *Diver. & Distrib*., 11(1): 3-23.

Zedam, A. 2015. Etude de la flore endémique de la zone humide de Chott El Hodna : Inventaire-Préservation. Thesis. Université de Sétif 1, Sétif, Algérie.

Zedam, A. and M. Fenni. 2015. Vascular flora analysis of the southern part of Chott El Hodna wetland (Algeria).*Adv. Environ. Sci.*,7(3): 357-368.

Zohary, M. 1973. Geobotanical Foundations of the Middle East, Gustav Fischer Verlag, 2 vols, Stuttgart, Germany. 739p.

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