BIODIVERSITAS
Volume 24, Number 4, April 2023
Pages: 2483-2491

ISSN: 1412-033X
E-ISSN: 2085-4722
DOI: 10.13057/biodiv/d240464

Floristic diversity of the steppe area of Tissemsilt, Northwest of Algeria

LAÏD GUEMOU[1,2,♥], SAHNOUNE FELLAH[2,3], MOHAMED MAIRIF[2], KADDA MOHAMED LAMINE CHOUHIM[2], BADREDDINE MOUSSAOUI[2,4], IKRAM NOURELHOUDA BOUZEMARENE[2], CHAHINEZ BOUBEKEUR[2]

[1]Laboratory of Improvement and Valorization of Local Animal Productions, University of Tiaret. BP 78 Zaaroura, Tiaret 14000, Algeria. Tel.: +213794429055, ♥email: laidgue@gmail.com.
[2]Department of Natural and Life Sciences, Tissemsilt University. Bougara Rd., Benhamouda, Tissemsilt 38004, Algeria
[3]Laboratory of Biological Systems and Geomatics, Mustapha Stambouli University of Mascara. Av. Cheikh El Khaldi, Mascara 29000, Algeria
[4]Laboratory of Beneficial Microorganisms, Functional Food and Health, Faculty of Natural and Life Sciences, Abdelhamid Ibn Badis University. Mostaganem 27000, Algeria

Manuscript received: 19 February 2023. Revision accepted: 30 April 2023.

Abstract. *Guemou L, Fellah S, Mairif M, Chouhim KML, Moussaoui B, Bouzemarene IN, Boubekeur C. 2023. Floristic diversity of the steppe area of Tissemsilt, Northwest of Algeria. Biodiversitas 24: 2483-2491.* This study uses a stigmatist phytoecological technique to survey and evaluate the plant diversity of the Tissemsilt steppe region. The floristic analysis allowed us to draw up a list of 105 taxa, including 86 genera distributed across 34 families with a dominance of Asteraceae (24.76%), Poaceae (9.5%), and Fabaceae (8.6%). The comparison of the different biological types showed the importance of Therophytes (51.42%) that adapt well to environmental conditions. On the biogeographical level, our study affirmed the affinity of the Algerian steppe vegetation with the Mediterranean flora. The methodology adopted for the biodiversity measurement through the flora analysis using several ecological indexes has disclosed an important diversity through the Shannon index (4.96). At the same time, the Evenness of Pielou indicated regularity in the distribution of species (0.73). However, the perturbation index (63.8%) revealed an environment opening. It confirmed the presence of the phenomenon of Therophytization in this region by the dominance of Therophytes annual species more or less needing trophic, water resources and opening areas.

Keywords: Diversity, ecological indexes, flora, steppe, Tissemsilt

INTRODUCTION

Since the Convention on Biological Diversity (CBD), it has been well established that biodiversity is an essential component of ecosystem functioning. Its loss compromises ecosystem integrity, negatively affecting human health and well-being (Borges et al. 2020). It is now widely acknowledged that there is a "biodiversity crisis," which means that ecosystems and species are not coping with the current drivers of local and global environmental change (Borges et al. 2020). Biodiversity is declining globally, but at different rates depending on taxonomic, functional, and evolutionary attributes. Understanding how these attributes influence ecosystem functioning is critical for better predicting the ecological consequences of biodiversity loss (Le Bagousse-Pinguet et al. 2019)

The Mediterranean basin is distinguished by a variety of physical and ecological uniquenesses that give its biodiversity significance as a world heritage. This region is home to at least 25,000 different species of vascular plants, 5,500 of which are unique, making it the third-most significant hotspot on Earth for plant diversity and one of the most significant habitats for endemic species (Bedair et al. 2023).

Algeria is a country belonging to the Mediterranean region, and includes a very important floristic wealth. According to Quézel and Santa (1962, 1963), the Algerian flora includes 3,139 species composed of 3,744 taxa of which 464 are endemic and 1,818 more or less rare species. This inventory is now evaluated at 4,449 taxa, including 3,951 native taxa and 498 introduced (Dobignard and Chatelain 2010, 2011a, 2011b, 2012, 2013). However, this richness is subject to intense pressure from man and his herds, leading to a strong degradation of the soil and vegetation cover (Arar and Chenchouni 2014; Houyou et al. 2016). Ecosystems and habitats change naturally (for example, because of natural climatic changes, volcanic eruptions, cyclones, and natural fires), but human-induced changes are now playing unprecedented roles in shaping the environment of our planet. In the last thousands of years of human evolution and colonization, they have promoted, for instance, the extinction of many species (particularly, large mammals and birds) with direct consequences for the structure and functioning of many ecosystems (Borges et al. 2020).

With more than 20 million hectares, the Algerian steppes are the most widespread pastures in North African countries. They extend between the two chains of the Atlas Mountains and stretch to the southern limit of Halfa grass range (Nedjimi and Guit 2012). Precipitation within this space is low and irregular, sometime in the form of flash downpours. The water balance is deficient and Sirroco, a hot summer wind, blows from the Sahara Desert for 20-30 days per year, triggering and accentuating the degradation of natural vegetation (Belala et al. 2018). Most of this area is currently either degraded or in an advanced state of degradation (Macheroum and Kadik 2015; Martínez-Valderrama et al. 2018). It is worth noting that rangeland degradation is mainly due to the combined impact of natural and socio-economic factors. For example, anarchic and irrational exploitation of resources, often with limited or even non-existent participation of local people in restoration and restoration programs are connected by country (Houyou et al. 2016; Salemkour et al. 2016; Hammouda et al. 2019).

Therefore, a better knowledge of the characteristics of the vegetation will lead to a better understanding of the structure of the ecosystems in order to propose sustainable management strategies. Indeed, according to Melom (2015), knowledge of the flora and vegetation is an indispensable tool to support sustainable development policies. It is within this framework that the present study aims to characterize the vegetation of the steppe territory of the province of Tissemsilt, Algeria.

MATERIALS AND METHODS

Study area

Located in the center of northwestern Algeria, the province of Tissemsilt occupies a natural hinge zone between the plain of Sersou and Chleff Valley and is bounded by natural barriers constituted by the mountains of Ouarsenis in the North and Jebel Nador in the South. Located 82 km in the southeast of the capital of the province of Tissemsilt (Northwestern Algeria), the study area "Selmana" (Figure 1) is administratively attached to the commune of Laayoune, with geographical coordinates between longitudes 2° 00' E' and 2° 18' E W and latitudes 35° 50' N and 35° 60' N, elevation: 850 m a.s.l.

Plant sampling and data collection

Therefore, to investigate the floristic diversity of steppe vegetation was carried out on a total of 46 phytoecological surveys distributed throughout the study area. Vegetation was surveyed during spring in 2019, 2020 and 2022, which represents the period of optimal vegetation development in arid lands of North Africa. The sampling area of each sample was 32 m^2. This area is commonly applied for sampling vegetation in the steppes with chamephytes of Tunisia and Algeria (Le Floc'h et al. 2007). The location of the 46 phytosociological surveys was chosen in zones that were clearly homogeneous and representative. The notice of the floristic and environmental data is based on the stigmatist method developed by Braun-Blanquet (1951). Each identified plant species was classified as annual, biennial or perennial following the persistence of the aerial vegetative part during the unfavorable season. The botanical identification of the collected taxa was made using the flora of Quézel and Santa (1962-1963) and Blamey and Wilson (2004). The species chorology was defined according to Dobignard and Chatelain (2010, 2011a, 2011b, 2012, 2013) and the flora of Maghreb (https://efloramaghreb.org). The nomenclature of the identified taxa was updated using the synonymic index of North Africa (Dobignard and Chatelain 2010, 2011a, 2011b, 2012, 2013). The plant specimens collected in the field have been deposited in a herbarium at the Department of Natural and Life Sciences of Tissemsilt University, Algeria.

Biodiversity analysis

The analytical or nonparametric estimation of species diversity (alpha diversity) was determined for the entire study area using several indexes (Marcon 2015): (i) Taxonomic 'specific' richness (S) that is the total number of distinct taxa of a community; (ii) The Shannon index, also known as the Shannon Weaver or Shannon Wiener index or simply entropy, comes from information theory (Marcon 2015) slightly modified by Vanpeene-Bruhier et al. *(*1998).

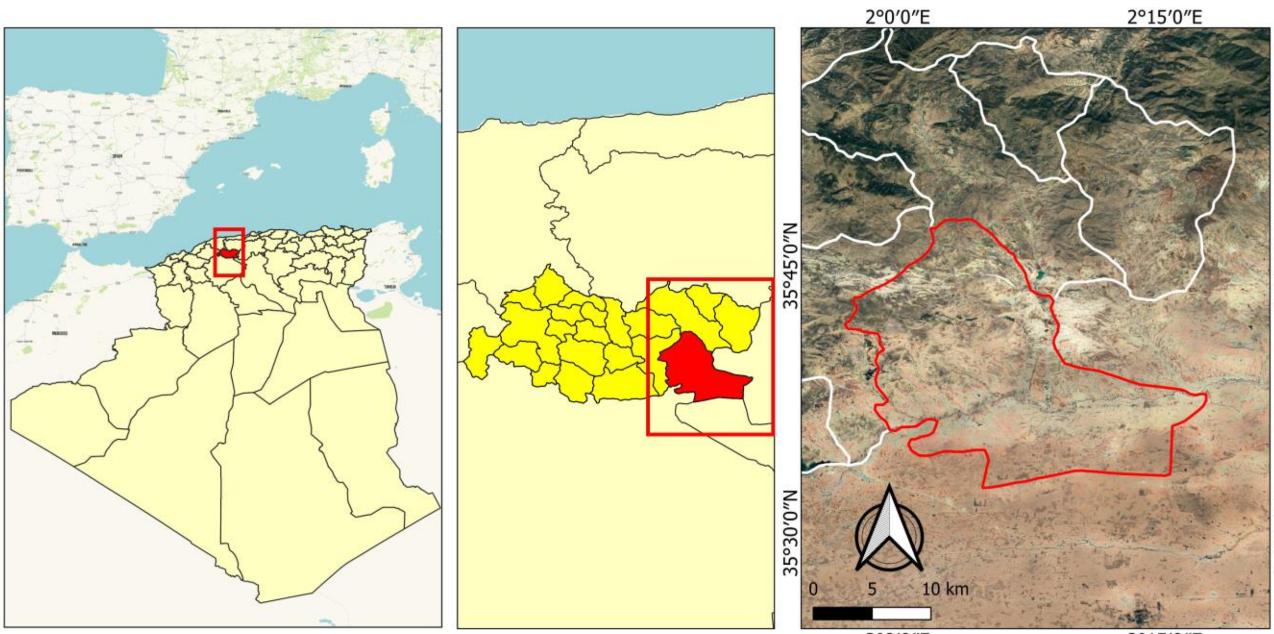

Figure 1. The geographical location of the study area in Tissemsilt, Northwest of Algeria

The specific diversity index H' (Shannon-Weaver) is based on the relative recovery *Rij* of the different species *j* in survey *i*, and the number of species present in the survey *i*: *ni* :

$$H' = -\sum_{i=1}^{s} \frac{R_{ij}}{\sum_{j=1}^{ni} R_{ij}} \log_2\left(\frac{R_{ij}}{\sum_{j=1}^{ni} R_{ij}}\right)$$

Our surveys are not done in the percentage of coverage, but with abundance coefficients, a preliminary transformation of the data is necessary.

(iii) H′ max is the theoretical maximum value of Shannon index (H′ max = $\log_2 S$);

(iv) The evaluation of specific diversity is generally completed by an index of Evenness (E). The Evenness (E) reflects the quality of the organization of a community. It is represented by the ratio between the measured diversity and the maximum theoretical diversity (E = H′/H′ max) and varies between 0 and 1. The maximum diversity could occur when all the species present a similar abundance. By convention, the diversity of a community increases when it tends towards equipartition (E > 0.5). Similarly, for a given evenness, the diversity increases when the taxonomic richness increases (Marcon 2015).

The Perturbation Index (PI) is used to quantify therophytisation. It is calculated according to Loisel and Gamila (1993) as the ratio of the sum of chamaephytes and therophytes on the full number of the species.

$$PI = \frac{(Number\ of\ chamaephytes + Number\ of\ therophytes)}{full\ number\ of\ species} * 100$$

RESULTS AND DISCUSSION

Bioclimatic study

Based on meteorological data provided by the meteorological station of Ksar Chellala and the site of tutiempo (https://fr.tutiemp.net) over the period 2002-2021, the climate of the study area is typically an arid Mediterranean climate. The wettest month was April (29.64 mm) and the driest one was July (7.73 mm). Rainfall had a seasonal pattern where the maximum is in spring (78.19 mm) and the minimum in summer (29.51 mm) with a seasonal precipitation regime of SAWS (SpringAutumnWinterSummer). Annual rainfall is very variable (233.02 mm/year on average), a characteristic of the arid climate but slightly lower than that of the arid zones of North Africa (Belala et al. 2018). The ombrothermic diagram distinguished a long period of dryness lasting about 12 months a year (Figure 2).

Emberger (1930, 1955) established a rainfall quotient specific to the Mediterranean climate, which is considered the most widely used in North Africa. It led to deducing the bioclimatic stage. With a value of "Q_2 = 23.43, we can say that the Selmana area is located in an arid bioclimatic stage with temperate winters. Following Köppen's climatic classification, the arid climate of the region characterized a hot steppe "BSh".

Floristic analyses

A total of 105 taxa from 34 families of vascular plants and 86 genera were recorded, which represents 2.44% of the total Algerian flora with 4300 species (Dobignard and Chatelain 2010, 2011a, 2011b, 2012, 2013; Mohammed et al. 2018). This number is similar to some of the results of studies conducted in the steppes of eastern Algeria (Maamri 2016; Maamar et al. 2018; Habib et al. 2020).

The largest families with the highest numbers of species were Asteraceae with 26 species (24.76%), Poaceae with 10 species (9.5%), Fabaceae with 9 species (8.6%) and Lamiaceae with 8 species (7.6%). These families alone represent 50.4 % of the inventoried species in this region (Figure 3). The specific place occupied by the Asteraceae, Fabaceae, and Poaceae is justified, since they are cosmopolitan families that are widespread throughout the world. These botanical families characterize North African steppes (Boughani 2014). In Algeria, some studies highlighted the dominance of these families in the steppe areas (Habib et al. 2020; Macheroum et al. 2021).

Other families as Brassicaceae, Apiaceae and Caryophyllaceae are represented with 5 species each (4.76%). The remaining families were present with less than 4%. Twenty-one families were represented by less than three species. This value indicates the high species adaptations to xeric conditions (Abd El-Khalik et al. 2017; Azizi et al. 2021; Bouallala et al. 2022). In addition, they reflect the characteristic of areas with accentuated aridity (Kouba et al. 2021).

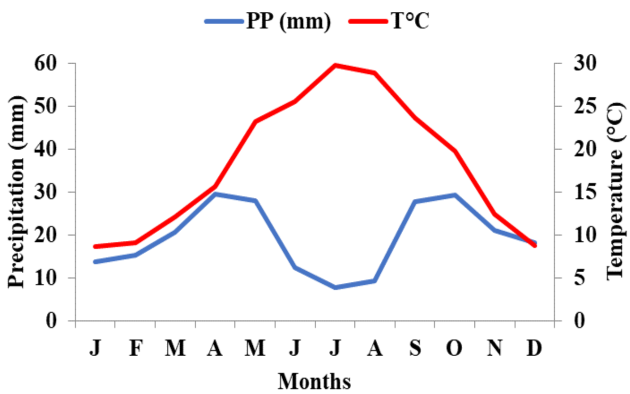

Figure 2. Pluviothermic diagram of Gaussen and Bagnouls applied for the region of Selmana (Northwestern Algeria). Mean temperature and precipitation are monthly averages based on long-term meteorological data (2002-2021)

Table 1. List of inventoried taxa

Taxa	Lifecycle form	Biological type	Chorological type
Aizoaceae			
Aizoanthemum hispanicum (L.) H.E.K.Hartmann	HA	Therophytes	Mediterranean Iranian-Turanic
Amaranthaceae			
Atriplex halimus L.	P	Phanerophytes	Cosmopolitan
Chenopodium album L.	HA	Therophytes	Cosmopolitan
Noaea mucronata (Forssk.) Asch. & Schweinf.	P	Chamaephyte	Mediterranean Iranian-Turanic
Apiaceae			
Ammi majus L.	HA	Therophytes	Mediterranean
Eryngium campestre L.	P	Hemicryptophyte	European Mediterranean
Eryngium ilicifolium Lam.	HA	Therophytes	Iberian-Mauritanian
Thapsia garganica L.	P	Hemicryptophyte	Mediterranean
Thapsia villosa L.	P	Hemicryptophyte	Mediterranean
Asparagaceae			
Asparagus horridus L.	P	Nanophanerophyte	Macaronesian-Mediterranean
Ornithogalum umbellatum L. ssp. *orthophyllum*	P	Geophytes	Atlantic-Mediterranean
Asphodelaceae			
Asphodelus fistulosus L.	P	Hemicryptophyte	Mediterranean Canary Circum
Asteraceae			
Anacyclus clavatus (Desf.) Pers.	HA	Therophytes	European Mediterranean
Andryala integrifolia L.	HA	Therophytes	West Mediterranean
Artemisia herba-alba Asso	P	Chamaephyte	Western Asia Canaria
Atractylis caespitosa Desf.	P	Therophytes	Iberian-Mauritanian
Atractylis cancellata L.	HA	Therophytes	Mediterranean Circum
Bombycilaena discolor (Pers.) Laínz	P	Therophytes	Eurasian, North Africa, Tripolitania
Calendula arvensis (Vaill.) L.	HB	Hemicryptophyte	Sub-Mediterranean
Carthamus lanatus L.	HA	Therophytes	European Mediterranean
Carthamus pinnatus Desf.	P	Hemicryptophyte	Sicily North Africa Libya
Centaurea pullata L.	HA	Therophytes	Mediterranean
Centaurea solstitialis L.	HA	Hemicryptophyte	Mediterranean Asian
Cirsium echinatum (Desf.) DC.	P	Hemicryptophyte	West Mediterranean
Filago pyramidata L.	HA	Therophytes	Mediterranean
Galactites tomentosus Moench	HB	Hemicryptophyte	Mediterranean Circum
Helminthotheca echioides (L.) Holub	HA	Therophytes	European Mediterranean
Hyoseris radiata L.	HA		European Mediterranean
Hypochaeris radicata L.	P	Hemicryptophyte	Euro-Caucasian
Mantisalca salmantica (L.) Briq. & Cavill.	P	Hemicryptophyte	European Mediterranean
Onopordum acanthium L.	HB	Hemicryptophyte	Sub-Mediterranean Eurasian
Onopordum tauricum Willd.	HB	Hemicryptophyte	Mediterranean Touranian
Pallenis spinosa (L.) Cass.	HA	Therophytes	European Mediterranean
Reichardia tingitana (L.) Roth	HA	Therophytes	Mediterranean
Scorzonera undulata Vahl	P	Chamaephyte	Mediterranean
Scorzoneroides hispidula (Delile) Greuter & Talavera	P	Hemicryptophyte	Mediterranean
Senecio gallicus Vill.	HA	Therophytes	Macaronesian-Mediterranean
Taraxacum laevigatum Maire	P	Hemicryptophyte	Mediterranean
Boraginaceae			
Echium creticum L.	HB	Hemicryptophyte	West Mediterranean
Brassicaceae			
Eruca vesicaria (L.) Cav.	HA	Therophytes	Mediterranean
Matthiola fruticulosa (Loefl. ex L.) Maire	P	Chamaephyte	Mediterranean
Sinapis alba L.	HA	Therophytes	Paleo temperate
Sinapis arvensis L.	HA	Therophytes	Paleo temperate
Sisymbrium officinale (L.) Scop.	HA	Therophytes	Cosmopolitan
Caprifoliaceae			
Lomelosia stellata (L.) Raf.	HA	Therophytes	West_ Mediterranean
Caryophyllaceae			
Herniaria hirsuta L.	HA	Therophytes	Paleo temperate
Paronychia capitata (L.) Lam.	P	Hemicryptophyte	Mediterranean
Saponaria sicula Raf.	P	Hemicryptophyte	Mediterranean
Silene conica L.	HA	Therophytes	Eurasian
Silene vulgaris (Moench) Garcke	HA	Therophytes	Eurasian
Cistaceae			
Cistus salviifolius L.	P	Nanophanerophyte	Eurasian Mediterranean
Helianthemum violaceum (Cav.) Pers.	P	Chamaephyte	Iberian-Mauritanian
Euphorbiaceae			
Euphorbia falcata L.	HA	Therophytes	Mediterranean Asian

Fabaceae			
Astragalus stella Gouan	HA	Therophytes	Mediterranean
Coronilla scorpioides (L.) W.D.J.Koch	HA	Therophytes	Mediterranean
Hippocrepis bicontorta Loisel.	HA	Therophytes	Sahara - Sindian
Medicago arabica (L.) Huds.	HA	Therophytes	Mediterranean
Medicago minima (L.) L.	HA	Therophytes	European Mediterranean
Médicago truncatula Gaertn	HA	Therophytes	European Mediterranean
Ononis reclinata L.	HA	Therophytes	Mediterranean
Retama raetam (Forssk.) Webb	P	Phanerophytes	Sahara - Sindian
Scorpiurus muricatus L.	HA	Therophytes	Mediterranean
Vicia sativa L.	HA	Therophytes	European Mediterranean
Geraniaceae			
Erodium ciconium (L.) L'Hér.	HA	Therophytes	Mediterranean
Erodium cicutarium (L.) L'Hér.	HA	Therophytes	Mediterranean
Iridaceae			
Moraea sisyrinchium (L.) Ker Gawl.	P	Geophytes	Paleo-Sub-tropical
Lamiaceae			
Clinopodium vulgare L.	P	Hemicryptophyte	Eurasian
Marrubium alysson L.	P	Hemicryptophyte	Moroccan-Iberian
Marrubium vulgare L.	P	Hemicryptophyte	Cosmopolitan
Salvia verbenaca L.	P	Hemicryptophyte	Atlantic-Mediterranean
Teucrium polium L.	P	Chamaephyte	European Mediterranean
Teucrium pseudochamaepitys L.	P	Chamaephyte	West Mediterranean
Thymus algeriensis Boiss. & Reut.	P	Chamaephyte	Endemic North African
Thymus munbyanus subsp. ciliatus (Desf.) Greuter & Burdet	P	Chamaephyte	Endemic North African
Linaceae			
Linum decumbens Desf.	HA	Therophytes	West Mediterranean
Linum strictum L.	HA	Therophytes	Mediterranean
Malvaceae			
Malva aegyptiaca L.	P	Therophytes	Sahara - Sindian Mediterranean
Malva sylvestris L.	P	Hemicryptophyte	Eurasian
Nitrariaceae			
Peganum harmala L.	P	Chamaephyte	Iranian-Turanian European
Papaveraceae			
Glaucium corniculatum (L.) Rudolph	HA	Therophytes	Mediterranean
Papaver rhoeas L.	HA	Therophytes	Paleo temperate
Plantaginaceae			
Linaria triphylla (L.) Mill.	HA	Therophytes	Mediterranean
Globularia alypum L.	P	Chamaephyte	Mediterranean
Plantago albicans L.	P	Chamaephyte	Mediterranean
Plantago coronopus L.	HA	Therophytes	Mediterranean
Poaceae			
Aegilops geniculata Roth	HA	Therophytes	Mediterranean
Anisantha rubens (L.) Nevski	HA	Therophytes	Paleo-Sub-tropical
Avena sterilis L.	HA	Therophytes	Macaronesian-Mediterranean-Iranian-Turanian
Hordeum murinum L.	HA	Therophytes	Boreal Circum
Lolium perenne L.	P	Hemicryptophyte	Boreal Circum
Lygeum spartum L.	P	Hemicryptophyte	West Mediterranean
Macrochloa tenacissima (L.) Kunth	P	Hemicryptophyte	Iberian-Mauritanian
Rostraria cristata (L.) Tzvelev	HA	Therophytes	Cosmopolitan
Stipa nitens (Ball) Ball	HA	Therophytes	Mediterranean Circum
Stipa parviflora Desf.	P	Hemicryptophyte	Mediterranean
Polygonaceae			
Rumex acetosella L.	P	Hemicryptophyte	Cosmopolitan
Primulaceae			
Lysimachia monelli (L.) U.Mann & Anderb.	P	Hemicryptophyte	West Mediterranean
Ranunculaceae			
Adonis annua L.	HA	Therophytes	Eurasian
Adonis dentata Delile	HA	Therophytes	Mediterranean
Resedaceae			
Reseda alba L.	HA	Therophytes	Eurasian
Resedaceae			
Reseda arabica Boiss.	HA	Chamaephyte	Sahara - Sindian
Rhamnaceae			
Ziziphus lotus (L.) Lam.	P	Phanerophytes	Mediterranean
Tamaricaceae			
Tamarix gallica L.	P	Phanerophytes	Nord tropical
Thymelaeaceae			
Daphne gnidium L.	P	Phanerophytes	Mediterranean
Thymelaea hirsuta (L.) Endl.	P	Nanophanerophyte	Mediterranean

Note: HA: Annual herbaceous; HB: biennials herbaceous; P: perennial

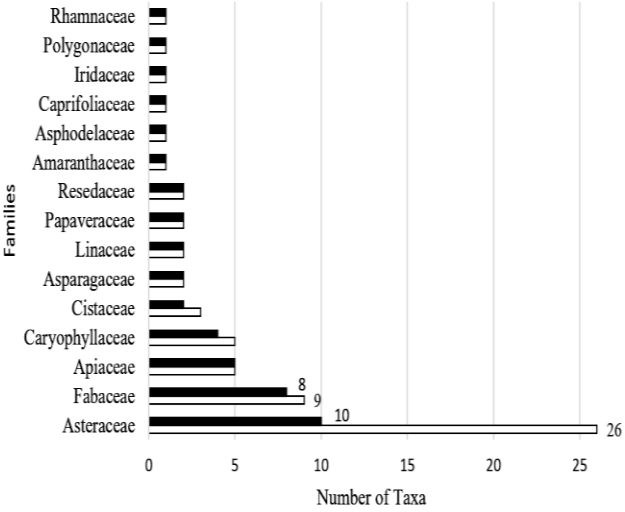

Figure 3. The most represented families (number of taxa)

Lifecycle forms

Plant form is one of the basic criteria in the classification of biological types. The flora consists of perennials, biennuals and annuals species. On the morphological level, the vegetation of our study area is marked by certain heterogeneity between woody and herbaceous species and also between those perennials and annuals. Based on abundance data, annual herbaceous plants occupy the first rank with (49%), followed by perennials (46%). However, 5% is recorded for herbaceous biennials (Figure 4). Flora composition analysis showed that the disturbance parameters promote the development of short-cycle plants, which are annual herbaceous. This is a common characteristic of vegetation in arid environments (Bradai et al. 2015; Abd El-Khalik et al. 2017; Salama et al. 2018; Senoussi et al. 2021). Cammeraat et al. (2010) stressed that perennial herbs have shallow root systems that catch water runoff and increase soil moisture and thereby facilitating the establishment of other species.

Biological types

The distribution of biological types of the various species recorded (Figure 5) is characterized by the following diagram: Th > He > Ch > Ph>Geo. It has been revealed the dominance of therophytes which constitute 51.42% of the floristic set, with a total of 54 species, a characteristic of the arid and semi-arid regions (Miara et al. 2016). This finding, associated with the presence of Fabaceae in the local flora can indicate the relative index of disturbance (Neffar et al. 2018). In the second rank come the hemicryptophytes, which are represented by 29 taxa or 27.61%. The chamaephytes occupy the third position with 13 species which represents 12.38%. These three biological types (therophytes, hemicryptophytes, chamaephytes) represent the majority largely compared to other biological types, which represent only 9.52%. Several authors, like Zahra et al. (2018) have highlighted the relationship between the high rate of therophytes and the increasing gradient of aridity in the Mediterranean grasslands. We are witnessing a therophytization caused by the aridity of the climate on the one hand and anthropization on the other hand (Sauvage 1961). This therophytization is also due to the phenomenon of self-mulching, a mechanism occurring in areas of high evaporation and in high salinity in-depth and covered with sand on the surface. Of the recorded flora, while geophytes were very scarce (1.9%).

In this study, the perturbation index has been used to assess firstly the state of degradation of our study area, which is expressed by the abundance of the two biological types, therophytes and chamephytes, and secondly corresponds to the two phenomena of degradation (therophytization and chamephytization) of arid and semi-arid zones. With 63.8%, this index showed that these formations, dominated by champhytic (*Artemisia herba-alba* and *Noaea mucronata*) and therophytes species, represent the most degraded formations, stemming from the steppe formations with *Stipa parviflora*, suffering a strong anthropic pressure. These plant groups correspond to the various formations of degradation formations of our study area. Results have been demonstrated by several studies (Habib et al. 2020; Macheroum et al. 2021). These authors exhibited the characteristic of the different stages of degradation in arid and semi-arid zones of Algerian steppe.

Chorological types

Phytogeography research is an important basis for any attempt to conserve biodiversity. It also constitutes a true model for explaining regression phenomena. The importance of biogeographic diversity in Mediterranean Africa can be explained by the migration of tropical flora caused by the climatic changes that the region has undergone since the Miocene (Quèzel and Barbero 1985).

Examination of the biogeographical spectrum of the species recorded (Figure 6) shows the predominance of species of Mediterranean biogeographic type with a percentage of 30.47% (32 species), among these species we can mention: *Euphorbia falcata* L., *Helianthemum violaceum* (Cav.) Pers., *Linum strictum* L., *Matthiola fruticulosa* (Maire), *Moraea sisyrinchium* (L.), *Plontago albicans* L., *Scorzonera undulate* Vahl, *Stipa parviflora*, *Thapsia garganica* L., *Thymus munbyanus subsp. ciliatus* (Desf.), *Sinapis alba* L., *Coronilla scorpioides* L., *Globularia alypon* L., *Plantago coronopus* L., *Médicago Arabica* L., *Sinapis arvensis* L. This is a reflection of our flora's logical and affinity for the Mediterranean region, which is generally appropriate given the region's climate.

The European Mediterranean type comes in the second position with 11 species (10.47%) taking for example: *carthamus pinnatus* Desf, *Erodium cicutarium* L., *Medicago minima* L., *Vicia sativa* L., *Medicago truncatula* Gaertn, *Erodium ciconium* L., *Hyoseris radiate* L., *Teucrieum polium* L. In the third place we have the west Mediterranean biogeographic type with 8 species (7.61%); we can mention a few of these species: *Andryala integrifolia* L., *Cirsium echinatum* Desf, *Echium creticum* L., *Linum decumbens* Desf. Other biogeographical types have been reported in the study area, such as: Cosmopolitan, Eurasian, Sahara-Sindian, European, Circum Mediterranean, Mediterranean Irano-Touranian, Paleo-Sub_tropical. The endemic type is represented with 2 taxa (1.9%). These taxa belong to North African elements. The number of endemic species reported in this study is quite low. An important reduction in the rates of endemic taxa in the steppe area was observed by other studies (Abdelmoumen and Zoheir 2015; Adi et al. 2016; Habib et al. 2020). In the Mediterranean region, these endemic taxa, even when they occur as Therophytes, are very fragile and vulnerable to anthropogenic disturbances (Quézel and Médail 2003).

Taxonomic diversity

For the whole study region, we have inventoried 105 species. The Shannon-Weaver index associated with the equitability index is realized on the global list of species. It allows having easily a better idea of the state of the biological diversity of an ecosystem. For the study area, their respective values are 4.93 and 0.73. These values indicate that the site is richly diverse and the community is quite even. We can say and through this result that the absence of dominant species in the steppe community implies a trend of the latter toward stability; this finding is reinforced especially by the high values of evenness (Macheroum et al. 2021).

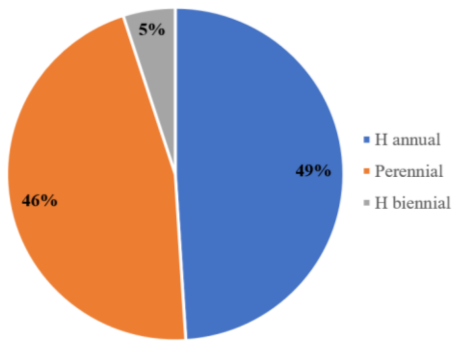

Figure 4. Morphology spectrum of the study area (H: Herbaceous)

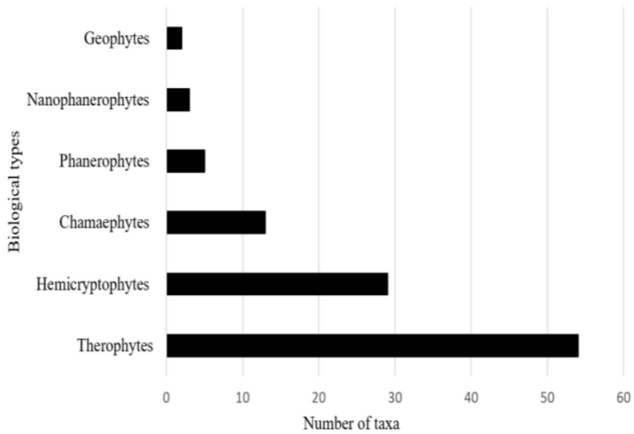

Figure 5. Biological types (number of taxa)

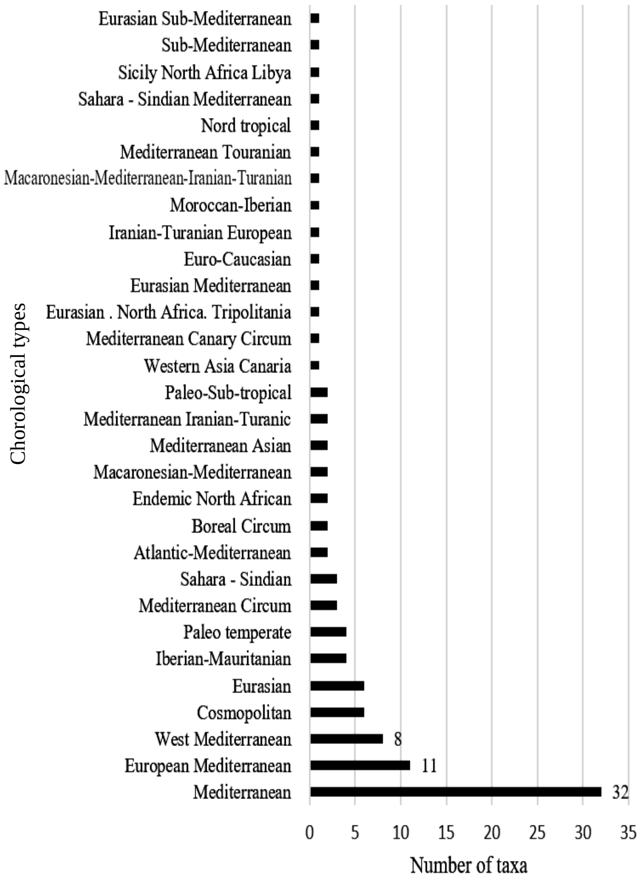

Figure 6. Chorological types (number of taxa)

In conclusion, this work was an attempt to study the floristic diversity of the steppe zone of Tissemsilt (NW Algeria). On the floristic level, a total of 105 species including taxa distributed on 34 families 86 genera with a dominance of four families are reported. Therefore, these are Asteraceae, Poaceae, Fabaceae and Lamiaceae. The biological spectrum showed the highest rates of therophytes in this area. This observation announces a therophytization which can be due to a dry climate and an anthropization. The dominance of therophytes explains the good adaptation to environmental conditions. This is confirmed by the chorological analysis which showed the absence of endemic plants (except for some endemics of North Africa). The phytogeography analysis showed the Mediterranean affinity of the Algerian steppe flora. Biodiversity index showed that the site is richly diverse with a uniform distribution of individuals between species. Based on this founding, the necessity and urgency to protect these natural spaces containing rich and original biodiversity remain an imperative operation more important than ever.

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