BIOLOGICA NYSSANA
13 (1) September 2022: 1-9

DOI: 10.5281/zenodo.7117398

Original Article

Community structure with particular reference to the effect of grazing in forest formations of Saïda (Algeria)

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Received: *August 16, 2021*
Revised: *May 04, 2022*
Accepted: *May 24, 2022*

Abstract:

To better understand and manage the forest vegetation of the Saïda district (types of vegetation present, floristic compositions, possible types of degradation), a total of 215 phytoecological surveys were carried out in the study area. In each survey, the intensity of the grazing and the presence or absence of regeneration of the tree layer were noted. The plant groups were determined using a modified TWINSPAN classification. For each vegetation group, the diagnostic species were selected based on their fidelity index (phi coefficient). We identified 9 plant groups and selected 147 diagnostic species. The results of this study showed that in the surveys carried out, there were more than 80% of moderately to heavily grazed, while in more than 70% of the studied plots, there was no regeneration of the main tree species. This alarming situation implies the rapid and effective implementation of protection and conservation measures.

Key words:
structure, forest formations, grazing, Saïda, Algeria

Apstrakt:

Struktura zajednica sa posebnim osvrtom na efekat ispaše u šumskim formacijama Saïda (Alžir)

Kako bi se bolje razumelo i upravljalo šumskom vegetacijom okruga Saïda (prisutni tipovi vegetacije, floristički sastav, mogući tipovi degradacije), u oblasti istraživanja prikupljeno je ukupno 215 fitocenoloških snimaka. Za svaku sastojinu utvrđen je intenzitet ispaše i prisustvo ili odsustvo regeneracije sprata drveća. Biljne grupe su utvrđene korišćenjem modifikovane TWINSPAN klasifikacije. Za svaku vegetacijsku grupu, dijagnostičke vrste su odabrane na osnovu vrednosti indeksa "vernosti" (phi koeficijenta). Identifikovali smo 9 biljnih grupa i selektovali 147 dijagnostičkih vrsta. Rezultati ove studije su pokazali da u više od 80% izvršenih istraživanja postoji prekomerna ili umerena ispaša, dok u više od 70% ispitivanih lokaliteta nema regeneracije glavnih vrsta drveća. Ova alarmantna situacija zahteva brzu i efikasnu implementaciju mera zaštite i konzervacije.

Ključne reči:
struktura, šumske formacije, ispaša, Saïda, Alžir

Introduction

Algeria is part of the Mediterranean basin, which has been described as one of the 34 "hotspots" on the planet (Myers et al., 2000). Indeed, Myers et al. (2000) consider that the Mediterranean countries hold almost 4.5% of the world's flora.

In recent decades, a number of stakeholders have threatened important habitats and their associated plants. An estimate of the extinction rate of higher Mediterranean plants is 0.15 percent of the total, representing 37 species presumed extinct, while 4,251 plant taxa are threatened (Greuter, 1994). It is therefore urgent to improve vegetation management.

The identification and description of plant groups, as well as their relationship to the environment, is a vital step in understanding arid environments (Al Harthy & Grenyer, 2019). First, different plant communities are considered as substitutes for ecosystem delineation, and community definitions therefore help to understand the macro-ecological differences between biosphere components (Al Harthy & Grenyer, 2019). Indeed, using ecological species groups and the presence-absence or coverage of their indicator species can help with the development of management plans and the selection of preferred practices for the long-term management of ecosystems, such as monitoring environmental changes, assessing management effectiveness, and providing warning signals for impending ecological changes (Barnes et al., 1982; Siddig et al., 2016). Effective conservation planning also includes identifying and describing plant communities (Kent, 2011; Brown et al., 2013).

In Algeria, knowledge on the structure of forest and preforest vegetation is still incomplete (Meddour, 2012). In this context, the present study aims to improve our knowledge on the structure of forest and preforest groupings in the Saïda region and to obtain an accurate inventory and a detailed diagnosis of existing plant groupings, possibly for mapping plant groups (elaboration of the typology). The final objective was always to better understand and manage natural areas (types of vegetation present, floristic compositions, conservation issues, possible types of degradation...). The results are intended for biodiversity specialists, managers of natural areas and/or naturalists.

Materials and Methods

Study area

The study area (forest formations and preforests), located in the district of Saïda in the northwest of Algeria with an area of about 174,361 hectares, between 35°6’23.68” and 34°35’9.14” latitudes North and 0°25’10.89” West at 0°47’28.58” longitudes East (**Fig. 1**).

Vegetation sampling

The inventory of flora is based on the 215 floristic surveys carried out through the forests area of the Saïda region during the years 2017-2018-2019

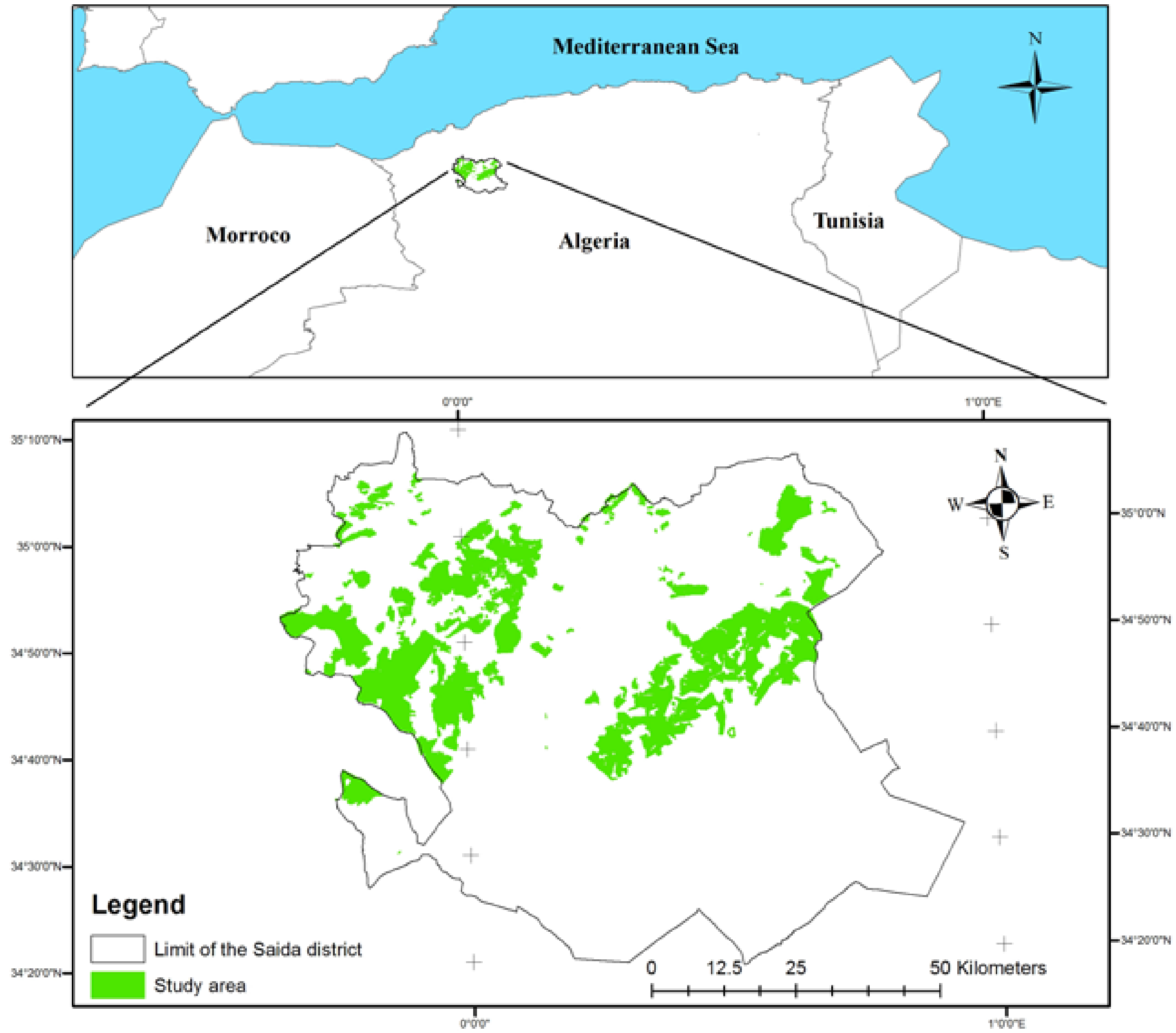

Fig. 1. Location of study area. Projection system is UTM zone 30-N, WGS84

between the periods of March to mid-June. The sampling plan used to analyze the vegetation is subjective. This is the simplest and most intuitive form of choosing as samples areas that appear particularly homogeneous and representative (Gounot, 1969; Terras, 2011).

The identification of the inventoried plant species was carried out using the New Flora of Algeria and the southern desert regions (Quézel & Santa, 1961-1962). In this study, the synonymic index of North Africa was used for the botanical nomenclature of species inventoried (Dobignard & Chatelain, 2010-2013). A total of 215 records were collected in the Turboveg database (Hennekens & Schaminée, 2001).

Floristic classification and statistical analysis

The phytosociological data were analyzed using the modified TWINSPAN (Two-way Indicator Species Analysis) method (Hill, 1979; Roleček et al., 2009), integrated into the program JUICE 7.0 (Tichý, 2002).

The minimum group size has been set at 3 and the coverage thresholds have been set at 0%, 5% and 25%. The Whittaker Beta Diversity Index (Whittaker, 1972) was used for the analysis of the heterogeneity of groups, because it provides balanced classifications, respecting the size and heterogeneity of the group, but also because of its robustness (Roleček et al., 2009).

To find an optimal cluster depth in the dendrogram produced by the modified TWINSPAN algorithm, we used the OptimClass procedure (Tichý et al., 2010), which is also implemented in JUICE. OptimClass was applied in mode 1. In naming plant groupings, we followed the informal approach of Menz et al. (2012) and Ik-Gürsoy et al. (2016) meaning that the nomination of plant groups always includes the name of the most diagnostic species and the species with the highest coverage.

Grazing intensity

To obtain an estimate of the grazing pressure in the study area, we used the following scale (Medjahdi, 2001; Medjahdi, 2010):

0 - absent;
1 - present but without causing damage other than on the herbaceous layer (very low);
2 - fairly significant damage to the herbaceous layer and to the foliage of the bushy layer (low);
3 - significant damage to the bushy layer (moderately);
4 - the heavily degraded forest undergrowth (height);
5 - almost total disappearance of the bushy layer (heavily).

Calculation of diversity indices

For each floristic survey the following indices were calculated using the JUICE 7.0 software (Tichý, 2002): Richness-index, Shannon-index, Eveness index and Simpson-index.

Species richness (S), Shannon-Wiener diversity index (H′) and Eveness index were calculated to describe the pattern of species diversity for each floristic record (i.e. alpha diversity - α), as well as for each plant group identified by TWINSPAN (that is to say the beta diversity - β). The differences between the mean values of the diversity indices between the plant groups were evaluated using a nonparametric analysis of variance with the Kruskal-Wallis test and the multiple comparison of the mean ranks. The differences were considered significant if $p<0.05$. This analysis was performed using SPSS 24.0 (Statistical Package for the Social Sciences).

To study species diversity and its relationship to the variables measured in this study, the data collected was examined using the Pearson correlation coefficient, which aims to draw a brief conclusion about the factors likely to affect species diversity.

Stratification and Recouvrement

To bring out the main lines of the vertical structure of the vegetation, only three strata were retained: arborescent, shrub and herbaceous. These three strata are identified according to the scale: tree stratum: (3 meters and more), shrub stratum (between 0.50 m and 3 m), herbaceous stratum (includes all non-woody species, these species do not exceed 0.50 m in general).

In each floristic survey we noted: the percentage of the overall recovery and the recoveries of the three identified strata, the presence or absence of the natural regeneration of the tree layer.

Results and discussion

Plant groups and diagnostic species

Free Based on the TWINSPAN analysis, and after the OptimClass1 analysis, nine plant groups were identified. Considering a cut-off value of 0.30 for the fidelity coefficient f, 58 diagnostic species were selected. These groups each have a particular floristic composition (**Tab. 1**). In its study in the same area Terras (2011) identified seven plant groups. This indicates the wide variation in the results of this study and the study conducted by Terras (2011). There are several reasons why a gap exists. This could be the difference in scale of the surveys, the difference in methods and style of assessment as well as the variation in anthropozoic factors such as fires and grazing (**Fig. 2**).

The overall recovery rate and the contribution of

Table 1. Synoptic table of vegetation sampling and species fidelity values in the nine groups

Group N	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
Number of floristic surveys	**6**	**47**	**5**	**16**	**34**	**4**	**39**	**11**	**53**
Total number of species	**15**	**83**	**35**	**54**	**136**	**23**	**99**	**62**	**144**
Group 1*: Asparagus albus- Pistacia atlantica*									
Asparagus albus L.	**87.5**	---	---	---	---	---	---	---	---
Pistacia atlantica Desf.	**75**	---	---	---	---	---	---	---	---
Ballota hirsuta Benth.	**69.9**	---	---	---	---	---	---	---	---
Psychine stylosa Desf.	**55.5**	---	---	---	---	---	---	---	---
Capsella bursa-pastoris (L.) Medik. subsp. *ábursa-p*	**55.5**	---	---	---	---	---	---	---	---
Calendula arvensis (Vaill.) L.	**54.8**	---	---	---	---	---	---	---	---
Group 2*: Olea europaea L.* subsp. *Europaea - Tetraclinis articulata*									
Olea europaea L. subsp. *europaea*	---	**64**	---	---	---	---	---	---	---
Drimia fugax (Moris) Stearn	---	**41.4**	---	---	---	---	---	---	---
Group 3*: Papaver rhoeas - Hordeum murinum*									
Papaver rhoeas L.	---	---	**94.2**	---	---	---	---	---	---
Clypeola jonthlaspi subsp. *microcarpa* (Moris) Arca	---	---	**73.5**	---	---	---	---	---	---
Avena sterilis L.	---	---	**69**	---	---	---	---	---	---
Carduus getulus Pomel	---	---	**67.9**	---	---	---	---	---	---
Hordeum murinum subsp. *leporinum* (Link) Arcang	---	---	**61.4**	---	18.1	---	---	---	---
Galium viscosum Vahl	---	---	**61**	---	---	---	---	---	---
Hohenackeria exscapa (Steven) Koso-Pol.	---	---	**61**	---	---	---	---	---	---
Coronilla scorpioides (L.) W.D.J. Koch	---	---	**61**	---	---	---	---	---	---
Dasypyrum hordeaceum (Coss. & Durieu) P.	---	---	**61**	---	---	---	---	---	---
Lolium perenne L.	---	---	**61**	---	---	---	---	---	---
Valerianella coronata (L.) DC	---	---	**54**	---	---	---	---	---	---
Group 4*: Juniperus oxycedrus* subsp. *oxycedrus - Quercus ilex*									
Juniperus oxycedrus L. subsp. *oxycedrus*	---	---	---	**46.6**	28.7	---	---	---	---
Ferula communis L.	---	26.4	---	**34.6**	28.8	---	---	---	---
Group 5: *Neatostema apulum- Macrochloa tenacissima*									
Neatostema apulum (L.) I.M. Johnst.	---	---	---	---	**50**	---	---	---	---
Carthamus pinnatus Desf	---	---	---	---	**46.3**	---	---	---	---
Paronychia arabica subsp. *cossoniana* J. Gay ex Ba	---	---	---	---	**44.6**	---	---	---	---
Plantago albicans L.	---	---	---	---	**40**	---	---	---	---
Atractylis cancellata L.	---	---	---	---	**36.4**	---	---	---	---
Anacyclus pyrethrum (L.) Link	---	---	---	---	**34.2**	---	---	---	---
Echinaria capitata (L.) Desf.	---	---	---	---	**34.2**	---	---	---	---
Scandix australis L	---	---	---	---	**32.6**	---	---	---	---
Group 6*: Quercus faginea*									
Quercus faginea Lam.	---	---	---	---	---	**100**	---	---	---

Smilax aspera L.	---	---	---	---	---	**84.1**	---	---	---
Nerium oleander L.	---	---	---	---	---	**79**	---	---	---
Dittrichia viscosa (L.) Greuter	---	---	---	---	---	**68.6**	---	---	---
Mentha suaveolens Ehrh.	---	---	---	---	---	**68.6**	---	---	---
Geranium molle L.	---	---	---	---	---	**68.6**	---	---	---
Oxalis pes-caprae L.	---	---	---	---	---	**68.6**	---	---	---
Group 7*: Pinus halepensis*									
Pinus halepensis Mill.	---	---	---	---	---	---	**53.5**	---	23
Helianthemum cinereum subsp. *rotundifolium*	---	---	---	---	---	---	**33.9**	---	---
Group 8*: Ziziphora hispanica - Macrochloa tenacissim*									
Ziziphora hispanica L.	---	---	---	---	---	---	---	**58.6**	---
Alyssum simplex Rudolphi	---	---	---	---	---	---	---	**58**	---
Globularia alypum L. subsp. *alypum*	---	---	---	---	---	---	---	**55.2**	29.4
Reseda collina Müll. Arg.	---	---	---	---	---	---	---	**52.6**	---
Teucrium polium L.	---	---	---	---	---	---	---	**51.4**	18.7
Erysimum grandiflorum Desf.	---	---	---	---	---	---	---	**50**	---
Achillea santolinoides Lag.	---	---	---	---	---	---	---	**50**	---
Ebenus pinnata Aiton	---	---	---	---	---	---	---	**48**	---
Erodium botrys (Cav.) Bertol.	---	---	---	---	---	---	---	**45**	---
Group 9*: Rosmarinus eriocalyx - Tetraclinis articulata*									
Rosmarinus eriocalyx Jord. & Fourr.	---	---	---	---	---	---	---	---	**56.7**
Cistus creticus L.	---	---	---	---	---	---	---	---	**43.9**
Quercus coccifera L.	---	---	---	---	---	---	---	---	**37.6**
Cistus clusii Dunal	---	---	---	---	---	---	---	---	**34.5**
Macrochloa tenacissima (L.) Kunth	---	---	---	---	---	---	---	---	**34**
Lavandula stoechas L.	---	---	---	---	---	---	---	---	**31.9**
Genista quadriflora Munby	---	---	---	---	---	---	---	---	**30.3**
Thymus munbyanus subsp. *ciliatus* (Desf.) G	---	---	---	---	---	---	---	---	**30.2**
Tetraclinis articulata (Vahl) Mast.	---	**56.3**	---	---	---	---	---	---	**35.5**
Quercus ilex L.	---	---	---	**55.7**	**43.8**	---	---	---	---
Asphodelus ramosus L.	---	---	---	**32.5**	**38.6**	---	---	---	---

each stratum to the overall recovery are summarized in **Fig. 3**. The overall recovery rate of the identified groups is high. This importance is mainly due to the strong contribution of the shrub layer. These values confirm once the openness of the environment and the role played by the shrub layer in the fight against erosion, the stability of the plant cover and the protection of the phytocenosis despite the attacks to which it is subjected (Medjahdi, 2010; Terras, 2011).

If we consider only the floristic richness (**Tab. 2**), we notice that the obtained results are logical, that is to say that the richness is decreased when the intensity of grazing is increased. In a recent study (Herrero-Jáuregui & Oesterheld, 2018), it was found that the effect of grazing intensity on species richness and diversity was negative for arid systems. According to our results, the correlation between grazing intensity and tree cover was absent, which also showed the high grazing intensity for all the plant groups identified in this study. A negative correlation was recorded between richness and tree cover rate (**Tab. 2**).

The average wealth index was higher in groups 3, 5, 8 characterized by a low tree cover which is between 0% and 14% (**Fig. 3**, **Fig. 4**). According to Quézel (2000), the matorrals constitute the vegetation structures undoubtedly the most remarkable of the Maghreb, because of their floristic richness. Similarly, Medjahdi (2010) indicates for the mountains of Traras that the floristic richness of

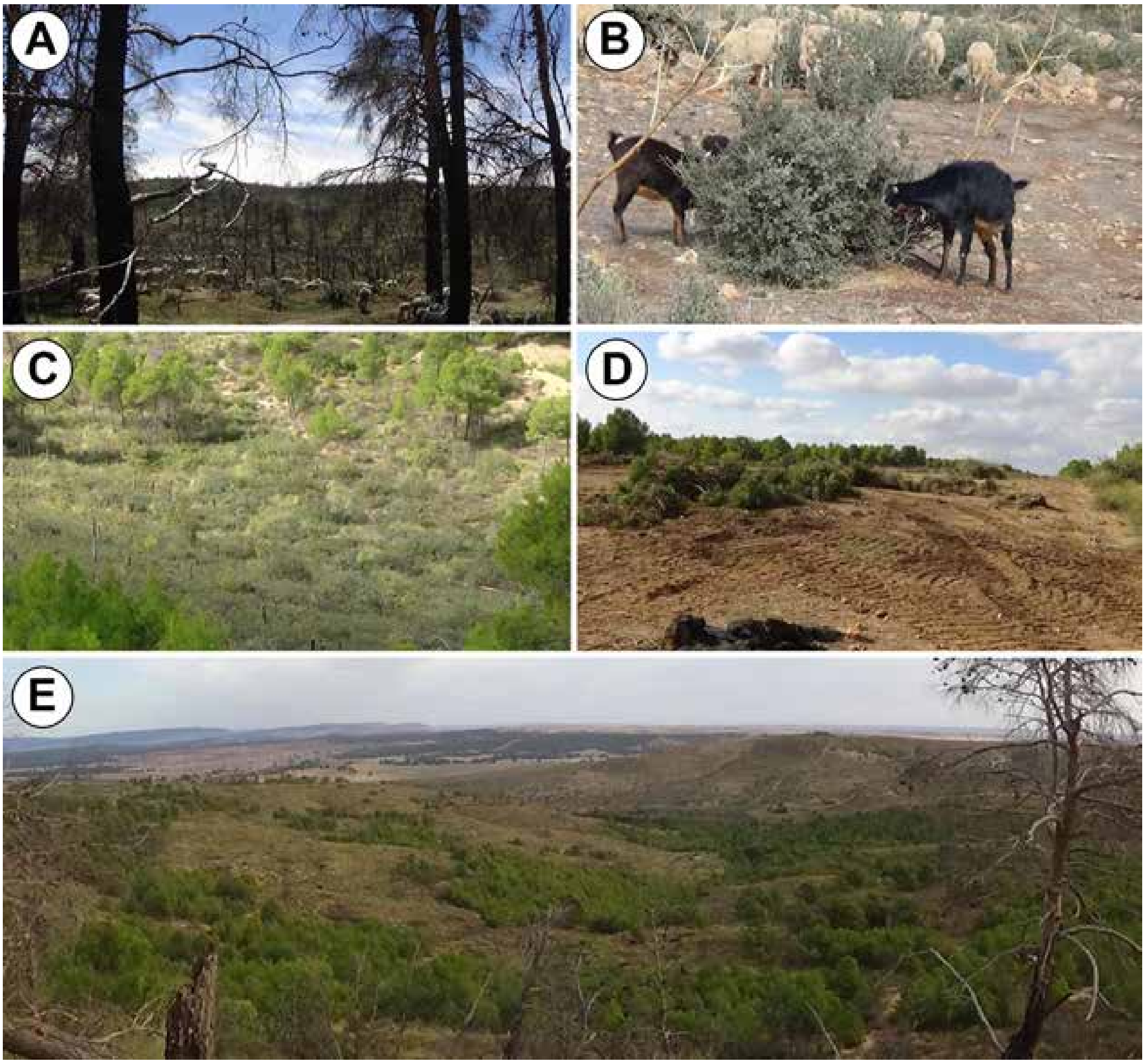

Fig. 2. Some of the anthropogenic actions in the pre-forest regions of Saïda (photos: Djebbouri. M). **A**: burnt stand of Aleppo pine (Djebel Aoun); **B**: pasture (Hssasna); **C**: misdemeanors and illegal cuts; **D**: Land clearing. (TENDFELT) massif; **E**: Aleppo pine groups spared by the fires

the habitats is maximum for the matorrals more or less open, it decreases in the case of closure of the medium.

The values of the SHANNON index are less strong overall (2.8 bits) and the equitability varies between 0.4 and 0.9, but they are higher in wooded matorrals than in closed formations (**Fig. 3**, **Fig. 4**). These results are confirmed by the negative correlation that has been recorded between the values of the SHANNON Index and the coverage rate ($p<0.05$) (**Tab. 2**).

According to Orth & Girard (1996), the Shannon Index has high values for species with similar recoveries and takes low values when a few species have high recoveries, whereas equitability tends towards 0 when a species has a very strong overlap and tends towards 1 when all species have the same importance. This is due to the presence of rare and infrequent taxa.

No quantitative studies on pastures have already been carried out in the Saïda region, so it is difficult to measure changes in vegetation composition and diversity. Nevertheless, based on the results of this study, it was evident that most of the groups identified in this study are severely disturbed by grazing. This is one of the main threats, indicated as more than 80% of the sites surveyed were moderately to heavily grazed and the rest showing signs of disturbance.

During the period of study and continuous observation of the vegetation, in more than 70% of the sites studied there was no regeneration of the main tree species such as *Pistacia atlantica*,

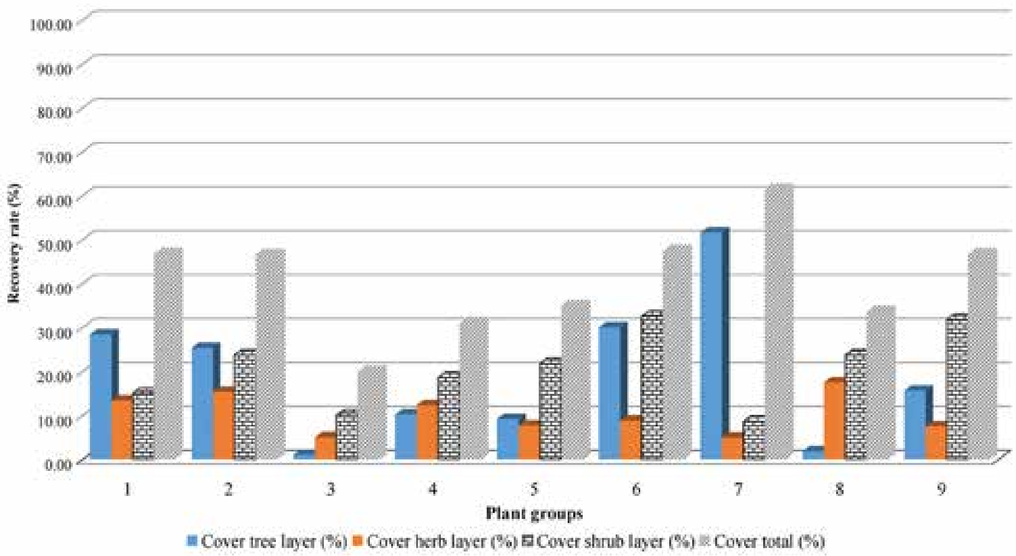

Fig. 3. The overall recovery rate and the contribution of each stratum to the overall recovery in each group of plants

Table 2. Pearson correlation between measured variables

	Richness index	Shannon index	Simpson index	Eveness index	Grazing intensity	Tree cover (%)
Richness index	1	0.830**	0.634**	0.499**	-0.269**	-0.367**
Shannon index		1	0.940**	0.824**	-0.176*	-0.657**
Simpson index			1	0.833**	-0.129	-0.733**
Eveness index				1	0.032	-0.697**
Grazing intensity					1	-0.025
Tree cover (%)						1

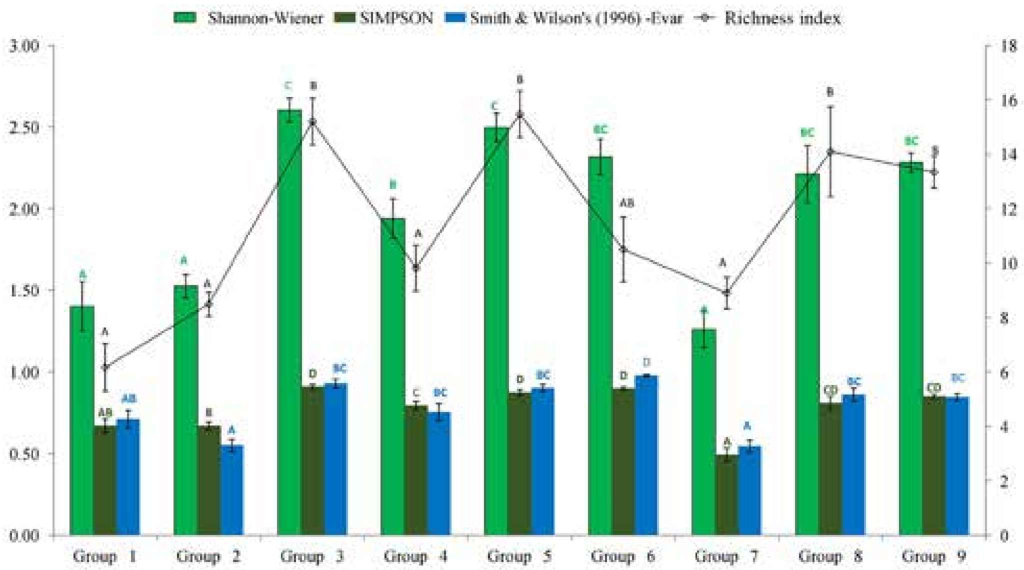

Fig. 4. Mean values of diversity indices (Means ± Standard error) in the identified groups of plant species. Different letters in each column indicate a significant difference at the 0.05 level according to the Kruskal Wallis test

Tetraclinis articulata and *Olea europaea*, *Quercus ilex* subsp. *ballota* (Desf.) Samp., *Pinus halepensis*, *Quercus faginea*, which is indisputably due to grazing ($\chi 2$ = 18.129, p = 0.0001). This has already been underlined by Benabedli (1996) who specifies that: "The course in forest formation constitutes a very degrading factor by its aggressiveness and the damage it causes to the vegetation and to the soil. Source of partial or total removal of plant cover, the unregulated route imposes the following degradation process: total exploitation of the herbaceous layer, consumption of young shoots, seedlings and suckers, grazing of the palatable bushy layer, pruning of the shrub layer". Louni (1994) also indicates that overgrazing thus has the consequence of eliminating by browsing young regenerations, low branches and suckers and the effects of trampling on the ground are also serious.

Indeed, this phenomenon of overgrazing has never ceased to endanger the entire forest heritage of the Saïda region. The excess livestock destroys the protective plant cover, while by trampling the surface of the soil powdery and by compacting it, it reduces the permeability of the soil, and therefore its water reserves (Ayoub et al., 2019).

Conclusions

The forest vegetation of the Saïda region has not been described in detail before. The need for classification and detailed description has become necessary. The present study allowed a better knowledge of the floristic composition and the structural characteristics through the 09 identified plant groups. The vegetation of the study area is quite rich and consists of 406 plant species. Nine (9) groups were discriminated against and the G9 group (*Rosmarinus eriocalyx - Tetraclinis articulata*) is the richest in terms of number of species with 136 species.

The diversity and equity indices show that there is a high diversity of species within the groupings and that many species participate in the recovery. The structure of the stands shows the dominance of the shrub character of the woody stratum in the groups. This testifies to the state of degradation and disturbance of the vegetation in this area subject to overgrazing and arid climatic conditions and further reveals the regressive trends in the overall dynamics of the vegetation. This alarming situation requires the rapid and effective implementation of protection and conservation measures. In order to maintain this biological wealth and safeguard this diversity of natural habitats, which remain strongly threatened due to the accentuation of the constraints of anthropogenic origins in these regions.

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