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FLORISTIC CHARACTERIZATION OF GRASSY STEPPE GROUPS IN NAAMA REGION (ALGERIA)

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Abstract

The present work aims to illustrate the current state of steppe rangelands based on three plant formations: Stipa tenacissima, Lygeum spartum and Stipagrostis pengens, and to describe the different floristic processions linked to these species in Nâama region with an arid climate. The phytoecological study is based on qualitative and quantitative analyses through 150 floristic surveys carried out during the spring period of the year 2022 in Nâama region. The floristic analysis enabled the identification of 62 taxa belonging to 23 families and 53 genera. The floristic procession is very rich and diverse in the three plant formations according to the Shannon indices (between 2.85 and 3.59) and equitability (0.68 and 0.86), where Asteraceae and Poaceae dominate the herbaceous layer in the study area. The three plant formations have great ecological plasticity and occupy an important place in the steppe rangelands of Naama. They tolerate extreme environmental conditions (drought, aridity, sandy substrates) well through adaptations using various strategies for occupying these specialized environments. The floristic evaluation of the steppe rangelands is necessary, even mandatory; in order to assess the pastoral potential and to identify solutions for the restoration and rehabilitation of these degraded steppe areas.

Keywords: rangeland, Naâma, arid, floristic, steppe, characterization

1. INTRODUCTION

Algeria covers a steppe area of 20 million hectares, located between the 400 mm isohyet to the south-north and the 100 mm isohyet to the south, and occupies a central position between the Tell Atlas to the north and the Saharan Atlas to the south.

It is characterized by a set of steppe plant formations of physiognomy, with a herbaceous and/or more or less shrubby character. It is represented by 4 main categories with climatic and edaphic determinism: dominated by perennial grasses such as (*Stipa tenacissima* and *Lygeum spartum*) and steppe of chamaephytes (*Artemisia herba-alba*, *Hammada scoparia*) growing in tufts [1-4].

In the Naama region, the steppe rangelands cover a significant pastoral area of three million hectares, including more than 400,000 hectares of esparto grasslands rangelands.

They are characterized mainly by very diverse plant formations with an abundance of cespitose grasses, a shrub layer (chamephytes) and an herbaceous layer, particularly therophytes (annual species).

This area is mainly composed of esparto grasslands (*Stipa tenacissima*), esparto rangelands (*Lygeum spartum*), psammophytic rangelands with Drinn (*Stipagrostis pungens*) and shrubby steppe rangelands with Remth (*Hammada scoparia*) [3,5,6].

Despite the ecological and economic role, the Naama steppe region has been facing a process of continuous degradation for several decades that is becoming increasingly irreversible.

This is mainly the effect of the combination of anthropogenic (overgrazing, land clearing) and natural factors (aridity, drought, etc.) [3-8].

This work was carried out in the steppe plains; it aims to study the formations of alfa (*Stipa tenacissima*), Sparta (*Lygeum spartum*) and Drinn (*Stipagrostis pungens*) as well as a floristic and ecological characterization of the area through a phytoecological approach.

2. MATERIALS AND METHODS

2.1. Presentation of the study stations

In the Naama region, the choice of study stations was made according to ecological factors (floristic-ecological homogeneity), as well as the presence of the steppe formations of study: *Stipa tenacissima; Stipagrostis pungens* and *Lygeum spartum* (Table 1 and Figure 1).

Table 1. Geographic coordinates of the study stations

Stations	Steppe plant formations	Geographic coordinates
Station 1 of Djedida	*Stipa tenacissima*	33°09'82,5" N
		0°23'23,8" W
Station 2 of Souiga	*Stipagrostis pungens*	33°09'40,9" N
		0°23'09,5" W
Station 3 of Hassi Lairedj	*Lygeum spartum*	33°16'56,0" N
		0°25'21,3" W

The first station of „Djedida": it is located 10 km from the city of Naama, dominated by the steppe formation based on alfa (*Stipa tenacissima*).

The second Station of „Souiga": it is located in the place called „Souiga" 17 km in the southern part of the city of Naama at a slope reaching 3%. It constitutes a homogeneous topographical ensemble without major accident. It is dominated by the psamophytic formation based on Drinn (*Stipagrostis pungens*) or the sand well colonized in this station.

The third station of „Hassi Lairedj": it is located west of the town of Naama, 10 km towards the road to Ain Ben Khelil. It is dominated by the presence of esparto (*Lygeum spartum*) associated with other species.

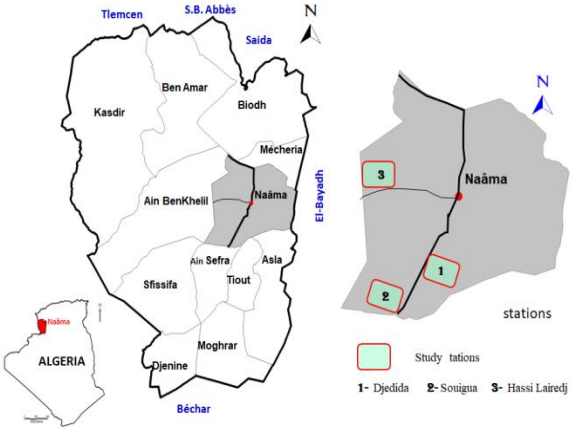

Figure 1. Location of study stations

2.2. Methodology

We carried out systematic sampling using a floristic survey with a minimum area of 100 m², which is widely used in steppe areas [1]. It consists of listing and identifying all the species encountered in the minimum sampling area [10]. Extending from April to June in 2022, the spring period of optimal vegetation, we were able to carry out 50 surveys at each station.

2.2.1. Quantitative analysis of data

- Recovery of vegetation is ideally defined as the percentage of the ground surface to be disseminated, if the aerial parts of the individuals of the species were arranged vertically on the ground [10].
- Floristic richness: The evaluation of the floristic richness will be determined by the number of species inventoried in the territory studied according to the scale of Daget and Poissonet [16].

2.2.2. Qualitative data analysis

- Biological analysis: According to the classification of Raunkiær [11] and Daget [12].
- Biogeographic analysis: In order to define the biogeographic characteristics we have chosen the studies of Quézel & Santa [13] and Le Houérou [14].
- Systematic analysis of species: The plants are identified using the following documents: new flora of Algeria [13] and Flora of Sahara [15].

2.2.3. Vegetation assessment

This assessment is determined by calculating the following indices:

- Shannon-Weaver Diversity Index (H')	$H' = \sum_{i=1}^{S} pi \log_2 pi$ Where: Pi= ni/N; ni: Coverage of species i in the survey. N: Sum of the recoveries of all species S; S: Specific richness	[18]
-Equitability Diversity Index of Pielou (E)	$E = H' / \log_2 S$ Where: **H'**: Shannon-Weaver index. Hmax ($\log_2$): Maximum theoretical diversity. S: Total number of species	[19]

3. RESULTS AND DISCUSSION

3.1. Quantitative analysis

- Recovery

Table 2. Vegetation cover rate in the study stations

Study stations	Plant steppe	Recovery (%)
Station 1 of Djedida	*Stipa tenacissima*	5% - 25%
Station 2 of Souiga	*Stipagrostis pungens*	5% - 20%
Station 3 of Hassi Lairedj	*Lygeum spartum*	5% - 20%

The average recovery in Djedida station is between 5% and 30% and in the two stations Hassi Lairedj and Souiga between 5% and 20%. The average vegetation coverage differs from one station to another, this can be explained by the diversity of the steppe formations (*Stipa tenacissima*, *Lygeum spartum* and *Stipagrostis pungens*) as well as the biotope where they develop, for example the psmmophytic steppe formation in Drinn which develop on sandy environments. This low coverage rate in the study stations is explained by the fact that the steppe formations are very open. Benaradj et al [7], indicate that the spread of dune formations in the steppe rangelands explains the low coverage of the rangelands. According to Daget & Godron [19], explain that the coverage rate is an indicator of degradation in regions threatened by desertification.

Figure 2. The levels of vegetation cover at study stations

- Floristic richness and systematic composition

Table 3. Floristic richness in the study stations

Study stations	Plant steppe	Floristic Richness
Station 1 of Djedida	*Stipa tenacissima*	53 species
Station 2 of Souiga	*Stipagrostis pungens*	25 species
Station 3 of Hassi	*Lygeum spartum*	31 species

Lairedj		

A total of 62 species are recorded in the set of three study stations. The Djedida station is characterized by the presence of 53 species, the Hassi Lairedj station with 31 species and finally the Souiga station with 25 species. According to the scale of richness of Daget and Poissonet [16], the floristic procession of the Djedida station is rich, as well as the procession of the Hassi Lairedj station and the Souiga station is quite rich.
The floristic richness in arid zone mainly belongs to annual species, environmental conditions and the relationship of all the characters (climate, edaphism and exploitation) [20].

3.2. Floristic composition

- Biological plan
All the stations have a difference from a systematic point of view. The results of the floristic composition of these stations are presented in the table below:

Table 4. Systematic characterization of the study stations

N°	Famille botanique	Djedida	Souiga	Hassi Lairedj	Study zone
1	Asteraceae	11	8	7	14
2	Poaceae	9	4	5	9
3	Fabaceae	6	1	1	6
4	Brassicaceae	4	2	1	4
5	Amaranthaceae	3	0	1	3
6	Lamiaceae	2	2	2	3
7	Borraginaceae	2	0	0	2
8	Caryophyllaceae	1	0	2	2
9	Cistaceae	2	2	2	2
10	Euphorbiaceae	2	1	1	2
11	Malvaceae	2	0	0	2
12	Zygophyllaceae	1	1	2	2
13	Apiaceae	1	0	1	1
14	Capparidaceae	0	0	1	1
15	Dipsacaceae	1	0	0	1
16	Onagaceae	1	1	0	1
17	Plantaginaceae	1	1	1	1
18	Renonculaceae	1	0	1	1
19	Resedaceae	1	0	0	1
20	Rhamnaceae	1	0	1	1
21	Scrophulariaceae	1	0	0	1
22	Tamaricaceae	1	1	0	1
23	Thymeleaceae	1	1	1	1
Total		**53**	**25**	**31**	**31**

a) *Djedida Station:* According to the table, it can be seen that the station is systematically characterized by the following floristic procession which consists of: 22 families, 50 genera and 53 species. Therefore, the station presents a clear dominance of the cosmopolitan family which is the Asteraceae family (with 10 genera and 11 species), followed by the Poaceae (with 8 genera and 9 species), then respectively by the Fabaceae family (with 6 genera and 6 species), the presence of the Amaranthaceae family with 3 genera and 3 species followed by the bigeneric families (Lamiaceae and Borraginaceae) with 2 genera and 2 species each. Families that contain only two genera and one species are Cistaceae, Euphorbiaceae, and Malvaceae. Finally, the remaining families are monospecific: Zygophyllaceae, Apiaceae, Dipsacaceae, Onagaceae, Plantaginaceae, Renonculaceae, Resedaceae, Rhamnaceae, Scrophulariaceae, Tamaricaceae and Thymeleaceae.
b) ***Souiga Station:*** It is systematically characterized by the following floristic composition: 12 families, 22 genera and 25 species. The floristic procession is characterized by the dominance of the Asteraceae family (6 genera and 8 species), followed in second position by the Poaceae family (4 genera and 4 species), followed by the Brassicaceae and Lamiaceae families (2 genera and 2 species) and the Cistaceae family with 2 genera and a single species. The remaining families are monospecific (with a single species) namely: Fabaceae, Euphorbiaceae, Tamaricaceae, Thymeliaceae and Zygophyllaceae.
c) ***Hassi Lairedj Station:*** This study station is systematically characterized by the following floristic procession which consists of: 15 families, 28 genera and 31 species. The floristic composition is dominated mainly by the Asteraceae family which is the most cosmopolitan with 6 genera and 7 species, followed in 2nd position by the Poaceae family (5 genera and 5 species), then in 3rd and 4th place by the bigeneric families of Lamiaceae, Caryophyllaceae and Zygophyllaceae (with 2 genera and 2 species) and the Cistaceae family (2 genera and 1 species). In some cases, we note the presence of monospecific families presented by a single genus and a single species such as: Fabaceae, Brassicaceae, Amaranthaceae, Euphorbiaceae, Plantaginaceae, Ranunculaceae, Tamaricaceae Rhamnaceae and Thymeliaceae
Overall, the families with the highest species content were Asteraceae and Poaceae. There is therefore a significant floristic diversity in these three steppe formations. These systematic analyses show a more nuanced diversity in families and genera in the different study stations. Asteraceae and Poaceae are two families common to the different study stations with a clear predominance in the floristic lists. These two families represent 35% of the flora. This predominance is justified since they are cosmopolitan families that are very widespread in the Mediterranean region. These families of Asteraceae and Poaceae have a greater power of adaptation to changes in ecological conditions and to anthropogenic pressures (overgrazing) in these environments [21]. The high proportion of Poaceae in the study area can be explained by the fact that these taxa have a very high possibility of tillering and a greater speed of regrowth after the passage of herds. They offer very significant fodder potential; which would encourage the exploitation of the rangelands for pastoral purposes.

3.3. Qualitative analysis

- Biological type

In the first station of Djedida, we find the following biological spectrum: Th>Ch>He>Ge> Ph. It is characterized by a strong presence of the herbaceous layer which predominates. Therophytes occupy 58%, chamephytes (21%). hemicryptophytes (17%), geophytes (2%) and phanerophytes (2%).

In the 2nd Station of Souiga: The biological type analysis in this station, shows that the biological spectrum of this station is dominated by the presence of Therophytic species (39%), followed by Chamephytic species (29%), followed by Hemicryptophytic species (26%), by Geophytes occupy the (3%) and Phanerophytes the (3%). The spectrum is of type: Th>Ch>He>Ge>Ph.

In the third station of Hassi Lairedj, the analysis of the illustrated results reveals that the dominant biological type is represented by therophytes (48%), followed by the Chamephytes (28%), and finally the Hemicryptophytes (16%), by the Geophytes occupy the (4%) and the Phanerophytes the (4%). Thus, the spectrum is comprised of (Th, Ch, He, Ge, and Ph).

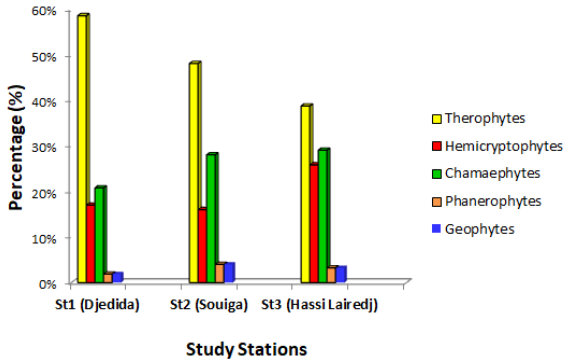

Figure 3. Diagramme of life form in the study area

The analysis of the global biological spectra shows that therophytes are the most represented throughout the study area, with rates generally exceeding 50%. The chamephytes are also well represented with different percentages, varying between 21% and 29%. The hemicryptophytes are less represented, their percentage is not negligible (19%), and followed by the geophytes and phanerophytes which record their rate of 4%. In all the study stations, the biological spectrum shows a predominance of herbaceous strata (therophytization).

In general, therophytes are the most dominant in all the studied rangelands at least in number. Their presence in arid environments is linked to their adaptation strategy. Several authors emphasize that therophytes are the biological type that directly depends on precipitation [22,23].

Emberger [24] states that the rate of therophytes increases with the aridity of the environment, for Daget [12] and Aidoud [25] therophysation is a characteristic of arid zones and expresses an adaptation strategy with regard to unfavorable conditions and resistance to climatic rigors. Therophytization described by many authors as a characterization of degraded systems is indeed valid if we have the passage from an ecosystem in good condition to another in poor condition.

- Biogeographic type

The study stations are rich in several phyogeographic elements; their distribution is different from one station to another. According to the figure, the distribution of phytogeographic types is generally as follows in the study area: Mediterranean; Endemic; Pluriregional; Saharan; Saharo-Sindian and Ibero-Mauritanian.

- Djedida Station is dominated by the presence first of the Mediterranean element (32%), followed by the Pluri-regional element with (20.75%), the Endemic element (18.87%), Saharo-Sindian element (13.24%), the Saharan element (9.83%), and the weak presence of the Ibero-Mauritanian element (5.66%).
- The phytogeographic spectrum analysis shows that the Souiga station is characterized by the dominance of the Mediterranean element with (32%), followed in second place by the Endemic element (19.35%). For the other elements are presented with low rate namely: Saharo-Sindian, the Ibero-Mauritanian element with a rate of 6.45%.
- For Hassi Lairedj Station, the biogeographic spectrum is characterized by the dominance of the Mediterranean biogeographic element with (32%), followed by the Pluri-regional element with (20%) then the endemic element with (16%).

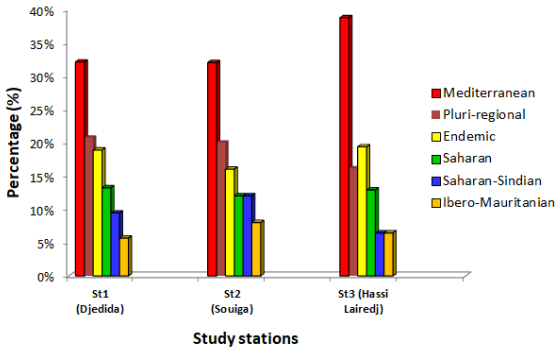

Figure 4. Biogeographic spectrum of study stations

All the study stations are characterized by a notable dominance of Mediterranean, endemic, and Saharan-Sindian species. The predominance of the Mediterranean element confirms the Mediterranean approach to the diversity of the region between the two groups: the high steppe plains and the Saharan Atlas to the South [3,7,21]. The Saharo-Arabian element increases in grazed areas. These results show an evolution of biogeographic types under the influence of changes in ecological conditions. Therefore, it appears that the study environment is diversified on the phytogeographic level [26-28]. This diversity is linked to two major series of causes: climate

changes that cause the migration of flora and long-distance transport by winds and birds [29].

3.4. Diversity indices (Shannon and Equitability) of the study stations

Table 5. Calculated diversity indices (H' and E)

Study stations	Shannon Index (H')	Equitability Index (E)
Station 1 of Djedida	3.59	0.86
Station 2 of Souiga	2.85	0.68
Station 3 of Hassi Lairedj	2.92	0.70

According to the results obtained (tab. 2), the Shannon (H') and equitability (E) indices show that they are significantly different. For Djedida station, the H' index (3.59) is average and the E index (0.86) high, which indicates that we have a fairly rich diversity, which can be explained by the dominance of annual and perennial species in the course, and the high value of the E index shows that there is a regular abundance of species.

According to Dajoz [30], the high value of the equitability index is an affirmation that there are favorable conditions for the appearance of many species and the dominance of some of them.

In the two courses of Hassi Lairedj and Souiga, they have low values of Shannon index and average values of equitability index, which shows a low diversity with the rarefaction of several species especially those that have a pastoral interest such as: *Helianthemum lippii, Salvia aegyptiaca, Saccocalyx satureioides.*

Khalid et al. [31], explain that the decrease in the value of diversity indices reveals a rarefaction close to a disappearance of certain plant species and especially those that have a good pastoral value. The impact of intensive grazing on the courses has resulted in a decrease in diversity indices [32].

4. CONCLUSIONS

In the Naama region, the steppe area is characterized mainly by low and very open plant formations, under a herbaceous, sub-shrub and exceptionally shrubby layer. The vegetation is characterized by the abundance of steppe plants (*Stipa tenacissima, Lygeum spartum, Stipagrostis pungens, Artemisia herba alba, Hammada scoparia*), but also by the frequency of annual species (therophytes). According to the floristic inventory, the floristic procession of the study area is quite rich (62 species divided into 23 families and 54 genera) with a recovery rate varying between 5 and 20%, this variation is reflected by the combined effect of climatic constraints and anthropogenic action. The analysis of the global biological spectra shows that therophytes are the most represented in all the study stations, with rates generally exceeding 50%. Chamaephytes are also well represented with different percentages, varying between 21% and 29%. Hemicryptophytes are less represented, their percentage is not negligible (18%), followed by geophytes and phanerophytes. The distribution of species expressed by adaptive strategies highlights the dominance of Therophytes and Chamaephytes in the stations. For the systematic composition, the stations are mainly dominated by Asteraceae and Poaceae. There is therefore a significant floristic diversity in these three steppe formations. These families have a greater power of adaptation to changes in ecological conditions and to anthropogenic pressures in these environments. For the biogeographic characterization, all the study stations are characterized by a dominance of the Mediterranean and endemic element.

In light of this work, it appears that these three grasses constitute a phytogenetic heritage of great interest on the social, economic and industrial levels which can play an important role in the agropastoral development of the Naama region, its current state requires us to take charge of this natural space to protect against degradation by conservation measures, rehabilitation and the integrated management of these steppe rangelands.

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