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ECOLOGY OF *VELLA PSEUDOCYTISUS* SUBSP. *GLABRATA* GREUTER IN THE NAÂMA REGION OF ALGERIA

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Abstract

The present study investigates the floristic composition and ecological characteristics of the *Vella pseudocytisus* plant group in the Kasdir region. The study employed 87 floristic surveys using the Braun-Blanquet method during the 2020 spring flowering peak. Species abundance, dominance, and sociability were analyzed alongside ecological and anthropogenic gradients through Correspondence Analysis (CA) and Ascending Hierarchical Classification (AHC). A total of 57 species were recorded, representing 49 genera and 20 families, with Poaceae, Asteraceae, and Fabaceae being the most represented. The biological spectrum reveals a dominance of therophytes (53.2%), followed by chamaephytes (23.5%) and hemicryptophytes (22%). The prevalence of therophytes, suggests ongoing ecological disturbance and overgrazing. Chamaephytic and psammophytic species, such as *Thymelaea microphylla* and *Astragalus armatus*, highlight adaptations to harsh and gypsum-rich soils. Biogeographically, the flora shows a strong Mediterranean component (26%), followed by endemic (23%) and Saharo-Sindian elements (12%). Five distinct vegetation units were identified, each with diagnostic and differential species tied to specific ecological conditions. The CA results underscore the importance of species-environment relationships, with anthropogenic impact and soil salinity emerging as key structuring factors. The study concludes that the *Vella pseudocytisus* group is undergoing significant degradation due to aridity and human activity. Conservation efforts are urgently needed, including habitat protection and ecological restoration, to safeguard this unique phytogenetic heritage. This research contributes valuable insights into steppe biodiversity, species adaptation strategies, and the conservation of vulnerable arid-land ecosystems in North Africa.

Introduction

Algerian arid steppe ecosystems are marked by a great landscape diversity linked to a variability of ecological factors. These ecosystems are characterized by limited natural resources, poor soil, low and open plant formations and severe climatic conditions (Boucherit *et al.* 2018, Boucherit *et al.* 2024, Boucherit *et al.* 2025).

In terms of flora, Chott El-Gharbi develops halophytic steppe that corresponds to areas of decreasing salinity from the inside to the outside (Benabadji *et al.* 2014). This arid ecosystem of Chott El-Gharbi is characterized by the very localized presence of *Vella pseudocytisus* subsp. glabrata, a shrubby and endemic species.

Vella pseudocytisus subsp. *glabrata* is a woody, perennial species endemic to the high steppe plains of southern Oranian in Algeria. The plant has many synonyms: *Pseudocytisus integrifolius* (Salisb) Rehder ssp. *Vella glabrescens* Coss. (Lit. and Maire) and *Pseudocytisus integrifolius* subsp. glabrescens (Cosson) Emberger. and *Vella pseudocytisus*. According to Benabadji *et al.* (2014) covers a fairly small geographical area. It is located mainly around the village El-Kasdir in the western part of Chott El-Gharbi. The objective of this work is to characterize the physiognomy

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and to give the current state and describe the characteristic floristic procession of the steppe grouping with *V. pseudocytisus* while basing itself on the phytoecological aspect in the region of Kasdir.

Materials and Methods

The study area is located in the western part of the High Steppe Plains (South-West Oran, Algeria). It is limited by the geographical coordinates 33°27'42.48''N and 33°41'52.8''N latitude and 1°23'11.4''W and 1°10'32.16''W longitude. The study area belongs to the commune of Kasdir, daïra of Mekmen Bern Amar, wilaya of Naama. It covers an area of 6378.13 km² of the territory of Naama (Benaradj 2017, Benaradj *et al.* 2021). The choice of the study area is nevertheless guided by the presence of the *V. pseudocytisuis* group which is the subject of study.

A quantitative and qualitative analysis was carried out on the floristic procession of the group in order to characterize the floristic diversity of the spaces occupied by the *V. pseudocytisus* grouping. The adopted approach is essentially based on the realization of 87 phytoecological surveys with a minimum homogeneous area of 100 m².

These floristic surveys were carried out during the spring (April and May) of the year 2020. Indeed, it is at this time that annual plants flower and complete their development cycle which only lasts a few weeks. The vegetation analysis was done based on the execution of floristic surveys according to the principles of the Braun-Blanquet method and by using numerical techniques mainly Factor Correspondence Analysis (FCA) and Ascending Hierarchical Classification (AHC).

Results and Discussion

In the chamaephytic steppe of *V. pseudocytisius*, the cover rate was 15 to 30%. This demonstrated that the study station was characterized by a very open plant formation. The results reveal that the *V. pseudocytisius* group represents a remarkable floristic richness where 57 taxa were identified so far (Fig. 1). The floristic procession of the *V. pseudocytisius* group was considered as a very rich group, because the procession includes a number between 51 and 75 taxa according to the reference scale of stationary floristic richness proposed by Daget and Poissonet (1997). The 57 species are under 49 genera and 20 families. According to Marino *et al.* (2024), floristic composition remains the best indicator of ecological conditions.

The *V. pseudocytisius* is a low woody formation of the Chamaephytic type. The species recorded within this steppe group are dominated by therophytes (29 species or 53.2%) and chamaephytes (13 species or 23.53%), then by hemicryptophytes (12 species or 22%), and geophytes (single species or 2%) (Fig. 1a). This variation in biological types often indicates changes in the state of the environment under the action of ecological and anthropozoic factors.

The biological spectrum highlights the importance of therophytes within the *V. pseudocytisius* grouping. Chriqui *et al.* (2024) paid particular attention to the distribution of therophytes, in the Mediterranean region. In the present experiment, the therophytic species accompanying the *V. Pseudocytisius* group were *Cleome arabica, Launaea nudicaulis, Peganum harmala, Malva aegyptiaca, Filago spatulata, Plantago albicans* and *Cutandia dichotoma*.

Amara and Bouazza (2024) considered *Plantago albicans* as a thermophilic species occupying arid pastures. In the present investigation, the presence of *Peganum harmala* and *Cleome arabica* in all the floristic surveys were noted. According to Benaradj *et al.* (2021), the appearance of *P. harmala* indicated overgrazing and showed the extent of anthropozoogenic action. The presence of *C. arabica* is experiencing significant expansion in grazed areas.

The analysis of the *V. pseudocytisius* group showed the importance of Chamaephytic species adapted to environmental conditions. Chamaephytic species includes *Echinops spinosus, Helianthemum lippii, Salsola vermiculata,* and *Noaea mucronata*. These perennial taxa settle in the lowest parts of the depressions where evaporation mechanisms promote the development of gypsum and nitrate efflorescences (Benabadji *et al.* 2014).

The presence of psammophilic species i.e., *Thymelaea microphylla, Astragalus armatus* were recorded. As for hemicryotophyes and geophytes, they are less important and represent only 13% each (Fig.1.a). This can be explained by the richness of the soil in organic matter and the high altitude (Benabadji *et al.* 2014). Geophytes are represented by *Lygeum spartum* and *Stipa parviflora*. Ghalem *et al.* (2023) pointed that these geophytes are certainly less diversified in degraded environments.

The Fig. 1b shows a significant quantitative presence of the Asteraceae family with a rate of 21% followed by Poaceae, Fabaceae (12%) and Brassicaceae (7%) and Caryophyllaceae (9%). The di-specific families are presented by a low percentage (4%) that can be cited as Amaranthaceae, Boraginaceae, Euphorbiaceae, Lamiaceae, Orobanchaceae and Zygophyllaceae. Mono-specific families were identified cumulating 15.75% of the group studied with 1.75% for each family. These are Apiaceae, Cistaceae, Cleomaceae, Ranunculaceae, Resedaceae, Thymeleaceae, Plantaginaceae and Aizoaceae. These species have a significant importance in the biodiversity of the study area.

Presence of Poaceae, Asteraceae and Brassicaceae is considered as an indicator of gypsum terrain (Benabadji *et al*. 2014, Adi *et al.* 2016). It is reported that the families mentioned here are very much present in steppe rangelands (León-Pesqueira *et al.* 2024, El-Amier 2015, Boucherit 2018).

From a morphological point of view, the floristic procession accompanying the grouping with *V. pseudocytisius* is marked by the heterogeneity between woody and herbaceous species and between perennials and annuals. Annual herbaceous species largely dominate with 71, 93%, and then perennial woody species occupy second place with 14% and finally perennial herbaceous species with 10.53% (Fig. 1c).

The biogeographic analysis of the flora within the *V. pseudocytisius* group allows to observe diversity in chorological elements in the chott El Gharbi. The phytogeographic study shows the importance of species with a Holarctic distribution, of which the Mediterranean ones are clearly dominant. The procession is less diverse because the region is very anthropized by overgrazing, cultivation and the scourge of sand encroachment which affects the entire southern Oran region of Algeria (steppe and chotts El Gharbi and El Chergui).

According to Fig. 1d, the Mediterranean element is relatively predominant (26%) in first place, the endemic element is marked with 23%, followed by Saharo-Sindian element (12%) and Saharan (11%) elements.

Multi-regional (7% each) and Cosmopolitan Ibero-Mauritanian, while the other elements are only marginally present: Med.-Ibero-Mauritanian with 5%, Iranian-Turanian with 5%, and Tropical with 4%. These findings, however, support the patterns noted by Le Houérou (1995) at the scale of the North African region, which indicated that of the 2630 vascular plant species found in the Maghreb steppes, 60% have Mediterranean affinity and 30% have tropical affinity.

The analysis of floristic data allowed to classify the 87 surveys and 57 species in groups distributed along various ecological gradients (Fig. 2, Table 1). The ecological profiles allowed describing the relationships between the species and their environment. The hierarchical classification allowed the binary index of Jaccard to distinguish 5 groups (A, B, C, D and E) of surveys (Fig. 2).

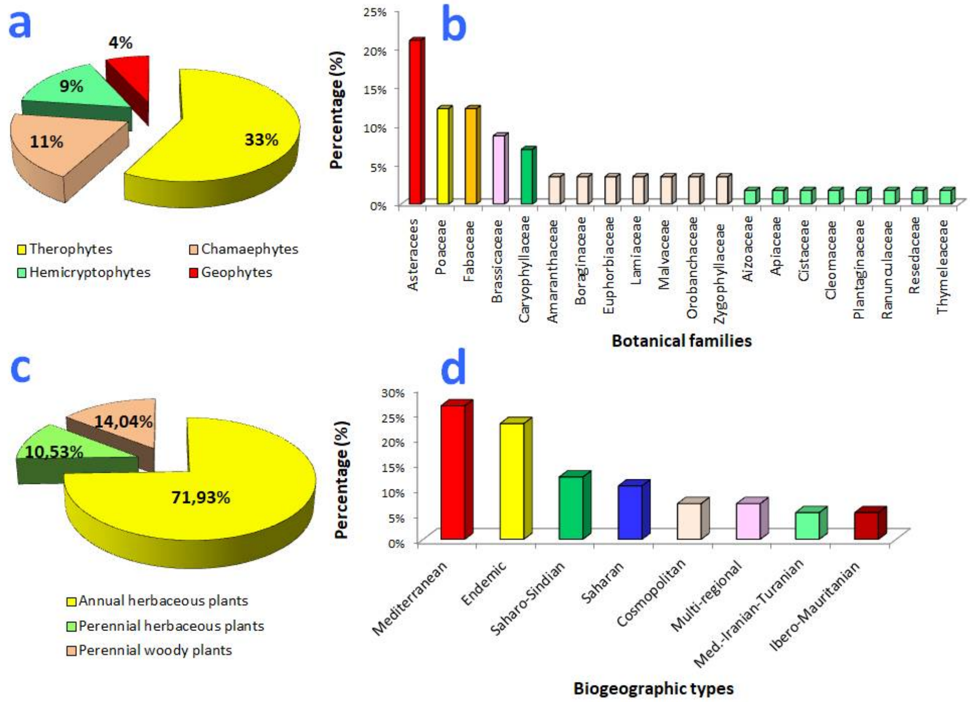

Fig. 1. Variation of floristic diversity, composition of *Vella pseudocytisius* grouping: (a) Life form, (b) Systematic, (c) Morphological types and (d) Biogeographic types.

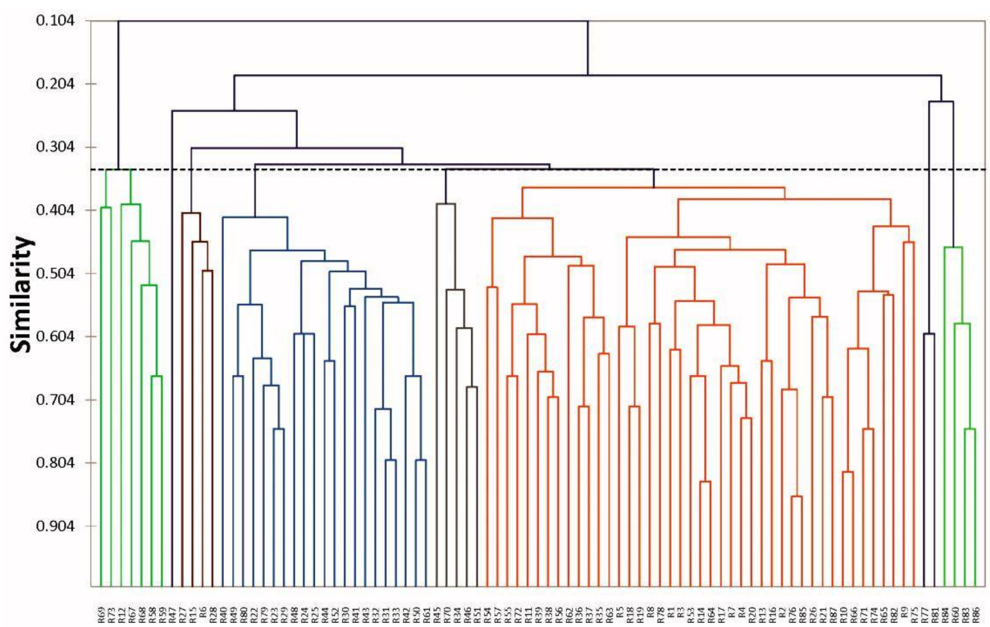

Fig. 2. Hierarchical classification of floristic data.

Table 1. Synoptic table of 87 floristic surveys from the Kasdir region, generated based on the Phi fidelity coefficient.

Groups	Group A	Group B	Group C	Group D	Groupe E
floristic Surveys	R40,R71,R66,R5, R49,R31,R32,R4, R29,R44,R48,R6, R33,R81,R80,R7, R79,R77,R22	R60,R5,R27, R84,R87,R8, R86,R28,R6	R16,R20,R1, R25,R24,R2, R85,R26,R7, R3,R4,R18, R7,R42,R50, R23,R8,R19, R1,R2	R63,R36,R3, R58,R45,R4, R59,R46,R3, R35,R30,R7, R68,R67,R51	R47,R72,R3, R38,R56,R5, R11,R57,R1, R69,R64,R1, R12,R9,R74, R73,R75,R1, R14,R54,R8, R65,R62,R53
Number of floristic surveys	**19**	**9**	**20**	**15**	**24**
Group A: Diagnostic species					
Euphorbia calyptrata	**36.2**	---	0	11	---
Plantago albicans	**33.2**	---	7.6	11.1	12.8
Atractylis carduus	**27.3**	---	---	5.3	---
Pituranthos chloranthus	**25.6**	---	---	---	8.2
Cistanche tinctoria ·	**20.6**	---	---	---	---
Group B: Diagnostic species					
Euphorbia guyoniana	---	**51.7**	27.2	---	---
Orobanche aegyptiaca	---	**41.9**	---	---	---
Sisymbrium runcinatum	---	**31.9**	---	---	---
Medicago polyceratia	---	**31.9**	---	---	---
Group C: Diagnostic species					
Salsola vermiculata	---	---	**34**	10.5	14.7
Cleome arabica	6.4	---	**33.5**	1.9	---
Marrubium desertii	5.8	---	**21.1**	---	7.8
Astragalus armatus	---	---	**20.1**	---	---
Aizoon hispanicum	---	---	**20.1**	---	---
Lappula redowski	---	---	**20.1**	---	---
Cynodon dactylon	---	---	**20.1**	---	---
Group D: Diagnostic species					
Xanthium spinosum	---	---	---	**84.6**	---
Hordeum murinum	---	---	---	**51.2**	6.8
Lygeum spartum	1.6	---	---	**40.3**	---
Astragalus cruciatus	---	2.3	---	**39.8**	---
Medicago laciniata	---	---	---	**34.4**	---
Cutandia dichotoma	---	7.7	---	**31.7**	---
Astragalus mareoticus	1.6	---	---	**28.9**	15.6
Amaranthus angustifolius	---	---	---	**23.2**	---
Polycarpaea repens	---	---	---	**23.2**	---
Paronychia arabica	---	---	---	**23.2**	---
Adonis dentata	---	---	---	**21.8**	5.1
Group E: Diagnostic species					
Herniaria fontanesii	---	---	---	---	**39.1**
Helianthemum lippii	---	---	---	15.1	**36.7**
Malva aegyptiaca	---	---	15.5	7.9	**36.3**
Gymnocarpos sclerocephalus	---	---	---	---	**32**
Paronychia arabica	---	---	---	---	**32**
Evacidium discolor	---	---	---	4.6	**30.4**
Salvia aegyptiaca	---	---	---	---	**26**
Arnebia decumbens	---	---	---	---	**26**
Pegannum harmala	---	---	6.5	16.9	**24.7**
Muricaria prostrata	---	---	---	7.4	**22.6**
Reseda decursiva	---	---	---	---	**18.3**
Scorzonera undulata	---	---	---	---	**18.3**
Differential species					
Thymelaea microphylla	**20.5**	---	**20.5**	1.4	---
Schimus barbatus	---	---	---	53.5	49.3
Cotula cinerea	14.1	---	---	---	18.8
Dilpotaxi pitardiana	---	---	---	10.7	15.6

Anacyclus cyrtolepidioides	---	---	16.8	---	12.4
Bromus rubens	---	---	---	15.5	6.9
Koelpinia linearis	---	14.6	---	1.2	6.2
Stipa parviflora	---	---	7.5	14.4	4.1
Generalist species					
Astragalus Gombo					
Atractylis humilis					
Alyssum cochleatum					
Atractylis serratuloides	12	---	8.8	---	---
Echinops spinosus	16.4	12.2	---	4.3	---
Launaea nudicaulis	9.3	4.1	---	18.2	---
Onopordon arenarium	---	13.4	3.3	13.4	---
Vella pseudocytisus	5.6	15.1	15.1	---	---

The phi reliability coefficient allowed extracting for each group of surveys a particular vegetation unit. Vegetation unit A (19 surveys) consists of 5 diagnostic species (strongly linked to each other and to this group of surveys) with a reliability coefficient ranging from 20.6 to 36.2. Vegetation unit B (9 surveys) consists of 4 diagnostic species with a relatively high reliability coefficient compared to unit A ranging from 31.9 to 51.7. Vegetation unit C (20 surveys) consists of 7 diagnostic species with a relatively equal fidelity coefficient compared to unit A ranging from 20.1 to 34. Vegetation unit D (15 surveys) consists of 11 diagnostic species with a relatively equal or higher fidelity coefficient compared to unit A ranging from 21.8 to 81.6. Finally, vegetation unit E (24 surveys) consists of 12 diagnostic species with a relatively equal fidelity coefficient compared to unit A ranging from 18.3 to 39.1.

Furthermore, we can distinguish between eight distinct species, which are common to two or three vegetation units: *Thymelaea microphylla, Schimus barbatus, Cotula cinerea, Dilpotaxi pitardiana, Anacyclus cyrtolepidioides, Bromus rubens, Koelpinia linearis, and Stipa parviflora. Astragalus gombo, Atractylis humilis, Alyssum cochleatum, Atractylis serratuloides, Onopordon arenarium, Launaea nudicaulis, Vella pseudocytisus* and *Echinops spinosus* are the eight generalist species that are found in all vegetation units and surveys, according to our final observation. The Multiple Correspondence Analysis (MCA) showed that the first 4 axes explain 60.91% of the information (Table 2).

Table 2. Eigenvalues and Total Variance explained of factorial axes (F1-F4).

	F1	F2	F3	F4
Eigenvalue	0.4409	0.0765	0.0514	0.0403
Inertia rate (%)	44.0874	7.6515	5.1411	4.0330
Cumulative %	44.0874	51.7389	56.8800	60.9130

The projection of the surveys is presented in the plane of axes 1 and 2 whose eigenvalues are respectively 0.44 and 0.07. The first axis explains 44.09% of the information which is positively correlated with the surveys R61, R23, R74, R64, R20, R79, R17, R26, R76, R50, R4, R2, R85, R22, R82, R18, R51, R29, R80, R71, R14, R8, R1, R59, R19, R44, R32, R16, R52, R13, R63 and R21. The main species forming this axis are *Vella pseudocytisus* (Vp), *Onopordon arenarium* (O), *Thymelaea microphylla* (Tm), *Plantago albicans* (Pl), *Pegannum harmala* (Ph), *Adonis dentata* (Ad), *Salsola vermiculata* (Sv), *Cleome arabica* (Ca), *Atractylis serratuloides* (As), *Astragalus mareoticus* (Am), *Schimus barbatus* (Sb), *Scorzonera undulata* (Su), *Polycarpaea repens* (Pr), *Reseda decursiva* (Rd), *Paronychia arabica* (Pa), *Amaranthus angustifolius* (Aa), *Cistanche tinctoria* (Ct), *Cynodon dactylon* (Cda), *Astragalus armatus* (Aar), *Lappula redowski* (Lr) and *Aizoon hispanicum* (Ah) (Table 2, Fig. 3).

Axis 2 explains 7.65% of the information which is positively correlated with the surveys R77, R86, R83, R81, R60, R49, R2, R84, R87, R13, R21, R31, R85, R50, R27 and the woody species *Thymelaea microphylla* (Tm), *Atractylis serratuloides* (As), *Vella pseudocytisus Vella pseudocytisus* (Vp), *Euphorbia guyoniana* (Eg) and *Cleome arabica* (Ca). Axis 2 separates woody species and annual species. It is negatively correlated with the surveys R11, R38, R59, R14, R57, R74, R56, R37, R9, R64, R58, R55, R72, R67, R12, R68, R73, R69 and annual species *Schimus barbatus* (Sb), *Pegannum harmala* (Ph), *Astragalus mareoticus* (Am), *Malva aegyptiaca* (Ma), *Adonis dentata* (Ad), *Xanthium spinosum* (Xs), *Herniaria fontanesii* (Hf) and *Helianthemum lippii* (Hl). This axis appears to express a gradient of therophyty (Table 2, Fig. 3).

Axis 3 explains 5.14% of the information which is positively correlated with the readings R9, R28, R68, R59, R6, R26, R60, R76, R87, R85, R84, R86, R73, R83 and to the species *Euphorbia guyoniana* (Eg), *Pegannum harmala* (Ph) and negatively correlated to R81, R80, R47, R40, R61, R33, R43, R48, R24, R41, R49, R30, R39 and to the species *Plantago albicans* (Pl), *Astragalus mareoticus* (Am) (Table 2 Fig.3).

Finally, axis 4 explains 4.03% of variability. This axis is positively correlated with the readings R53, R76, R14, R81, R18, R65, R78, R8, R77 and the species of *Salsola vermiculata* (Sv), *Marrubium desertii* (Md) and negatively correlated with the records R83, R84, R86, R59, R40, R69, R60, R67, R31, R27, R29, R80, R68, R37 and to the species *Astragalus mareoticus* (Am), *Euphorbia guyoniana* (Eg), *Onopordon arenarium* (O), *Euphorbia calyptrata* (Ec) and *Xanthium spinosum* (Xs) (Table 2, Fig.3).

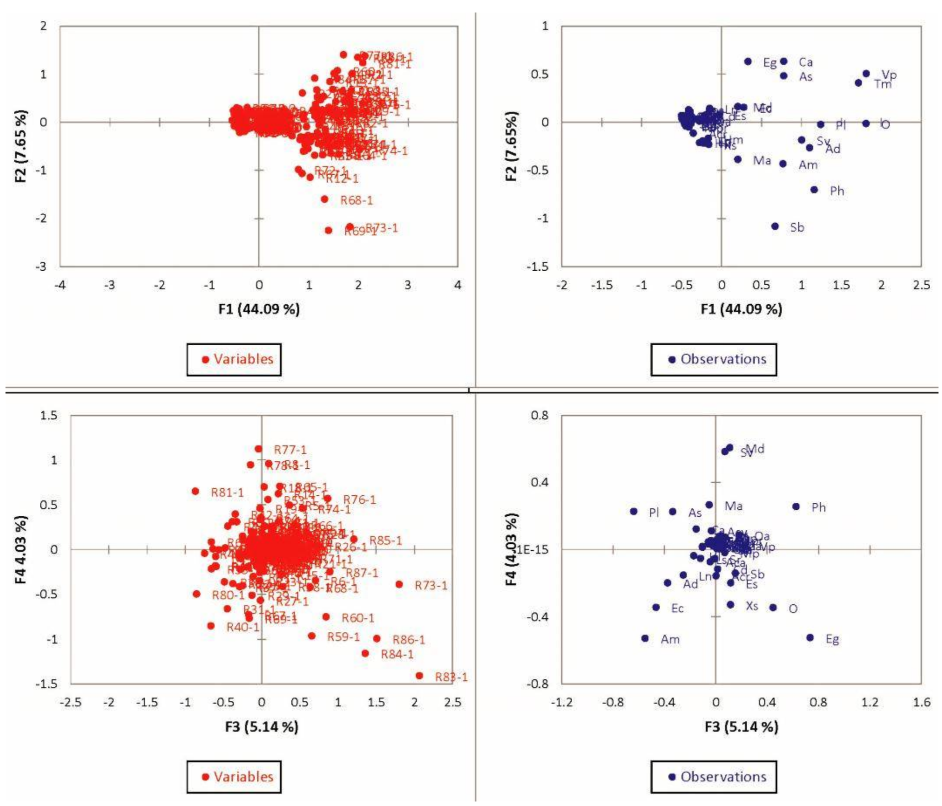

Fig. 3. Distribution of taxa on factorial plans (F1/F2 and F3/F4).

On the factorial levels, the distribution of taxa that gather in a cloud in the center of the axes can be explained by a low recovery rate, which, under the importance of the anthropogenic impact, generates a degradation gradient that is the result of overgrazing, given the pastoral vocation of the region. The anthropogenic effect is expressed by the invasion of thorny species (*Atractylis cancellata, Astragalus armatus*) and toxic species (*Peganum harmala, Cleome arabica*) disdained by livestock. The same observation is declared by Benaradj (2017) and Anteur *et al.* (2022).

The improvement of the water balance and the sandy accumulations around the individuals of *Vella pseudocytisus* promote the germination of annuals leading to a certain restoration of the plant community (Benabadji *et al.* 2014). Thus, a gradient of psammophytization is marked by a deposit of sandy accumulations on the feet of the taxon of *V. pseudocytisus*, which allows the installation of psammophyte species.

The analysis allowed to characterize the floristic procession that accompanies the *V. pseudocytisus* grouping in the western Algerian steppe plains both on the systematic, biological, morphological and biogeographical level and to evaluate the biological diversity on the quantitative and qualitative aspects.

Ecologically, this grouping evolves in an arid lower Mediterranean bioclimatic stage with cold winters and hot and dry summers. This climatic trend characterizes the Chott El Gharbi region and can have influences on the floristic procession. On the edaphic level, the grouping develops on shallow (40-50 cm) gypsum-calcareous salty soils (alluvial depressions) generally poor in organic matter with coarse textures (silty-sandy). Systematically, the group is floristically rich with 57 species divided into 24 genera and 14 botanical families, the most representative of which are Poaceae (32.43%) and Fabaceae (21.62%).

The study of the floristic procession showed the dominance of xerophytic and halophytic species with an abundance of annual species with a percentage of 62.35% followed by halophilic Chamaephytes. Phytogeographically, there is a clear dominance of Mediterranean species (55.26%).

In recent decades, the *Vella pseudocytisus* group has been in continuous degradation, the synergistic action of aridity and anthropic action generating a regressive dynamic of the floristic procession. It is essential to implement a rehabilitation and restoration strategy through the creation of a protected reserve or permanent protection in order to safeguard and conserve what remains of this original endemic and/or threatened phytogenetic heritage of *Vella pseudocytisus* in the Chott El Gharbi in Algeria.

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