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Phytosociological analysis of the Sidi Boughaba Biological Reserve, Kénitra, Morocco

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Key words: phytosociology, correspondence factorial analysis, cartography, syntaxa, Morocco.

Ključne besede: fitocenologija, korespondenčna faktorska analiza, kartografija, sintaksoni, Maroko.

Abstract

The biological reserve of Sidi Boughaba has a unique plant biodiversity, with many animals, including birds, finding refuge there. Data on this biodiversity is old and incomplete. This phytosociological study was carried out to define the vegetation structure of the area. Stratified sampling was carried out and 124 relevés were recorded. Multivariate statistical analyses (correspondence factorial analysis and hierarchical ascending classification) used to process the relevés revealed the presence of 9 plant groups, including 4 plant associations and 5 subassociations, which belong to 3 phytosociological classes (*Ammophiletea*, *Quercetea ilicis* and *Querco roboris-Fagetea sylvaticae*). *Quercetea ilicis* is the most widespread in the area, showing several successional stages on grey and consolidated dunes. Vegetation of *Ammophiletea* can only be found on mobile sand. Vegetation of the class *Querco roboris-Fagetea sylvaticae* occupies an inter-dunar depression on hydromorphic soil. The association *Pterido aquilinum-Populetum albae* is newly described as five subassociations of *Clematido cirrhosae-Juniperetum lyciae*.

Izvleček

V rezervatu Sidi Boughaba se nahaja edinstvena diverziteta rastlin s številnimi živalskimi vrstami, predvsem pticami, ki v njem najdejo zatičišče. Podatki o tej raznolikosti so stari in nepopolni. Da bi opredelili strukturo vegetacije v tem območju, smo izvedli fitocenološko raziskavo s stratificiranim vzorčenjem in naredili 124 vegetacijskih popisov. Z multivariatno statistiko (korespondenčna faktorialna analiza in hierarhična klasifikacija) smo popise razdelili v 9 skupin, od tega v 4 asociacije in 5 subasociacij, ki jih uvrščamo v tri razrede (*Ammophiletea*, *Quercetea ilicis* in *Querco roboris-Fagetea sylvaticae*). V rezervatu je najbolj razširjena vegetacija razreda *Quercetea ilicis* s številnimi sukcesijskimi stadiji na sivih in utrjenih sipinah. Vegetacijo razreda *Ammophiletea* najdemo na mobilnem pesku, razred *Querco roboris-Fagetea sylvaticae* pa se pojavlja v depresijah med dinami na hidromorfnih tleh. Opisali smo novo asociacijo *Pterido aquilinum-Populetum albae* ter 5 subasociacij asociacije *Clematido cirrhosae-Juniperetum lyciae.*

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Introduction

The Sidi Boughaba Biological Reserve is a wetland located on the Atlantic coast in western Morocco. It is a refuge for fauna, in particular birds, which find a welcoming environment in the humid atmosphere and the rich and varied vegetation. The faunal diversity is estimated at 205 species, including 37 sedentary species, 34 migratory species that winter regularly, 13 nesting species and 8 non-breeding species (Cherkaoui et al., 2013). Vegetation of the region was studied by Atbib (1983) and Jdi et al. (1987), while the most recent study on floristic diversity mentions 221 taxa (Bathaoui, 2001); since then, no vegetation investigations have been carried out in the area. A synthesis of climatic data for a period of 34 years (1982–2016) compared to syntheses of the periods 1948–1970 (Atbib, 1983) and 1957–1981 (Jdi et al., 1987) showed that the bioclimatic stage of the area has migrated from subhumid with temperate winters to semi-arid with cool winters (Challi et al., 2021). Following this migration, the area is now at significant risk of erosion, which would have an impact on the reserve's habitats. These habitats offer a high level of biodiversity, sheltering animal and plant species, including rare or endangered species. Studying this vegetation is important in that it helps managers to draw up appropriate management programs. Indeed, the landscape around the reserve has undergone major changes, with urban growth and coastal development. There is a lot of tourist traffic within the reserve, and visitor activities are not always environmentally friendly. That said, red juniper forest is well developed on the consolidated dunes and seems to harbor a considerable range of flora. Similarly, the hygrophilous vegetation around the "merja" (=lake) is remarkable for its diversity. It is therefore useful to study this biodiversity to see to what extent the change in climate, protection measures and the change in the surrounding landscape have impacted on the vegetation.

The aim of this study was to define the plant groups found in the reserve and to compare them with previous descriptions and summaries (Atbib, 1983; Jdi et al., 1987).

Materials and Methods

Study area

The Sidi Boughaba Biological Reserve is a protected area, included in the Ramsar list since 1980. It is therefore part of a complex of wetlands in Morocco, giving it international importance as an ornithological site. It is located in the south of the province of Kenitra and is oriented NNE-SSW. It extends between 34°12' N and 6°42' W on the Atlantic coast in northwest Morocco (Figure 1) and is bounded to the north by the mouth of the Oued Sebou. The area covers 650 ha, 450 of which are covered by vegetation and 200 by "merja" (= lake). To the west, white dunes are made up of loose limestone sand; grey dunes of the Quaternary run parallel to them to the east and then, further inland, are slightly higher consolidated sandstone dunes of the Middle Quaternary.

The climate of the region is Mediterranean with an oceanic influence. The average annual rainfall in Kénitra is 544.5 mm, with an average maximum temperature of 38.9°C in the hottest month (August) and an average minimum temperature of 1.5°C in the coldest month (January) (Challi et al., 2021). The main soil types are sandy in the majority of the study area. They are classified as (i) raw mineral soils on unconsolidated white dunes, (ii) calco-mesimorphic soils of eolian origin and sandy texture on deep sand and dune sandstone, (iii) sandy-clay Mediterranean red soils, not very humus-rich, on slopes, superficial on dune sandstone and very deep in the interdune depression and (iv) hygromorphic soils corresponding to the water table, with sandy horizons of varying depths (Aubert, 1965; Duchauffour, 1982).

Sampling

In the spring of 2017, 20 homogeneous habitat types were determined on the basis of different physiognomies. A total of 124 relevés were taken from these habitat types, considering the different plant layers (Table 1). The number of relevés per habitat type was variable and depended on the floristic heterogeneity and the area explored (Figure 2).

The phytosociological study was conducted according to the Braun-Blanquet (1964) approach. The relevés were recorded with a standard plot size of 100 m², considered sufficiently representative in Mediterranean plant formations (Fennane, 2003). For each relevé, GPS coordinates with latitude and longitude, altitude, slope and exposure were noted. Sampling was carried out during three consecutive years: June 2017, April and May 2018 and June 2019.

A summary table presents the relative frequencies (F %) of the different species inventoried in the reserve (Table 2), with F % = (number of relevés in which the species is present / Total relevés)*100; this information was used in the numerical analyses (Meinard & Thébaud, 2019). The nomenclature of the plant communities identified follows Benabid (2000) and new communities are described according to Theurillat et al. (2021).

The plant material collected was identified in the laboratory based on the three volumes of the Practical Flora of Morocco (Fennane et al., 1999; Fennane et al., 2007; Fennane et al., 2014).

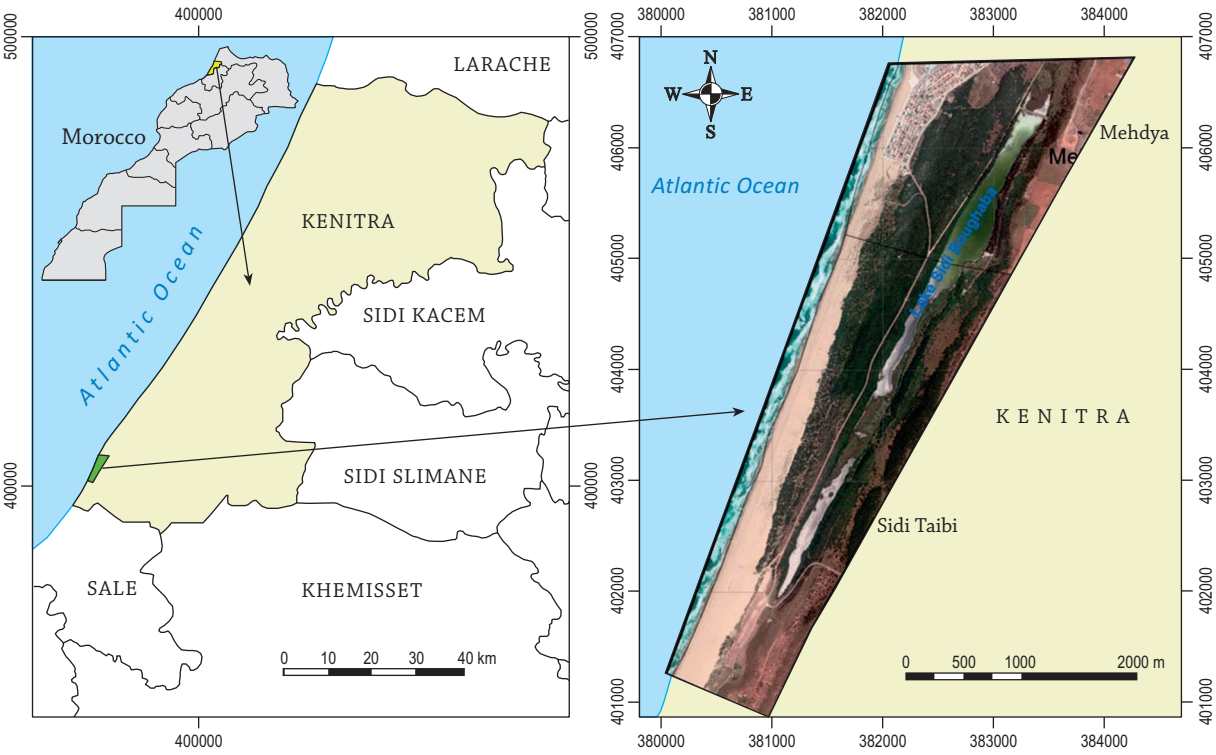

Figure 1: Location map of the Sidi Boughaba Biological Reserve.
Slika 1: Lokacija rezervata Sidi Boughaba.

Table 1: Geographical location and area of the 20 habitat types studied.
Tabela 1: Lokacije in površina 20 preučevanih habitatnih tipov.

Habitat types (Ht)	Number of relevés	Area (ha)	Lambert coordinates (Km)		Geographical coordinates	
			X (Km)	Y (Km)	Longitude	Latitude
Ht1	29	110.30	381.08	403.24	-6.6909 W	34.2245 N
Ht2	9	38.29	381.74	404.56	-6.6839 W	34.2365 N
Ht3	7	35.94	381.27	402.99	-6.6888 W	34.2222 N
Ht4	20	172.59	382.30	405.12	-6.6779 W	34.2416 N
Ht5	4	22.37	383.26	406.62	-6.6677 W	34.2552 N
Ht6	9	21.33	380.81	401.38	-6.6936 W	34.2077 N
Ht7	1	9.95	380.98	401.30	-6.6917 W	34.2069 N
Ht8	3	10.80	381.13	401.31	-6.6902 W	34.2071 N
Ht9	3	20.70	381.50	402.58	-6.6863 W	34.2186 N
Ht10	1	10.03	381.36	402.08	-6.6877 W	34.2141 N
Ht11	19	71.99	382.67	404.29	-6.6738 W	34.2341 N
Ht12	1	4.63	381.64	402.65	-6.6847 W	34.2192 N
Ht13	4	24.53	382.38	404.12	-6.6769 W	34.2326 N
Ht14	2	2.88	383.71	406.63	-6.6628 W	34.2553 N
Ht15	2	3.80	382.88	404.96	-6.6716 W	34.2402 N
Ht16	1	0.62	383.31	406.32	-6.6671 W	34.2525 N
Ht17	2	4.81	381.43	401.91	-6.6869 W	34.2125 N
Ht18	5	9.73	383.17	405.66	-6.6686 W	34.2465 N
Ht19	1	2.70	383.53	406.03	-6.6647 W	34.2499 N
Ht20	1	2.95	383.81	406.65	-6.6618 W	34.2556 N

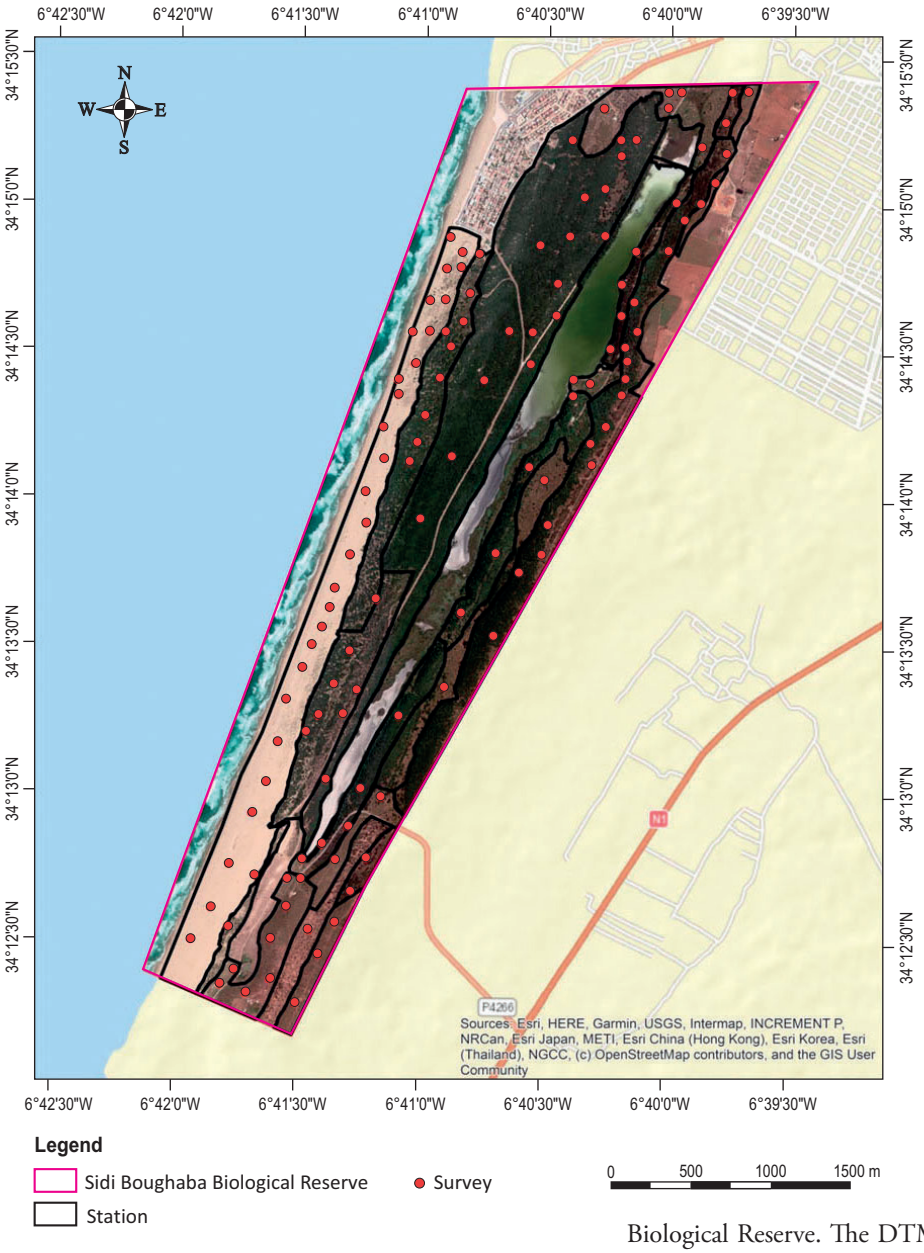

Figure 2: Location of the habitat types (black line limits) based on the homogeneous physiognomy of the plant communities and location of the relevés (red points).
Slika 2: Karta habitatnih tipov (omejeni s črno črto) na osnovi homogene fizionomije rastlinskih združb in lokacije vegetacijskih popisov (rdeče točke).

Data analysis

A Digital Terrain Model (DTM) provides complete topographic and altimetric information (values of slopes, altitudes). It is therefore possible to draw up thematic maps based on the processing of relief information alone, or its combination with data of a different nature. The data collected and ordered in altitude classes thus allowed the elaboration of a hypsometric map of the study area (Figure 3). This gave a synoptic view of the terrain and information on its geomorphology. The various maps (hypsometric, slopes) were produced by ArcGIS 10.3 software (ESRI, 2015) using the DTM of the Sidi Boughaba Biological Reserve. The DTM was also used to establish a slope map using the (create slope & aspect) function; each point on the slope map corresponds to the value of the slope on the ground. The map thus produced allowed us to identify slope classes that provide information on the slope of the area (Figure 4).

Using IBM-SPSS (IBM Corp., 2010) statistics software, statistical analyses of the collected floristic data were then performed. The processing of all the data was carried out after transforming the Braun-Blanquet abundance-dominance coefficient index into ordinal values in accordance with the suggestion of van der Maarel (1979), by replacing the + code with the value 0.5 and the r code with the value 0.1.

We used a four-letter code for the species (for example: DJPH where D=Dounia and JPH = *Juniperus phoenicea*). Correspondence factor analysis was followed systematically, with a hierarchical ascending classification whereby the data processed corresponded to a matrix of 124 relevés and 270 species. Species occurring only once were excluded from the analyses.

Results and Discussion

Data on the elevation and slope of the study area were collected and processed by ArcGis 10.3 software and used to produce the maps (Figure 3). The altitude varied from 6 to 77 m and the slope from 0 to almost 48%.

During vegetation sampling, we recorded 270 species belonging to 199 genera and 58 families, the most represented of which were Fabaceae and Asteraceae. Only 38 taxa had a frequency higher than 16% (Table 2) whereby *Juniperus phoenicea* and *Retama monosperma* were the most frequent, with a frequency of nearly 65% and 56%, respectively (Table 2).

Table 2: List of the most frequent species in the Sidi Boughaba Biological Reserve (P: number of relevés in which the species was present; F (%): Frequency).

Tabela 2: Seznam najbolj pogostih vrst v rezervatu Sidi Boughaba (P: število popisov, v katerih je bila vrsta prisotna; F (%): frekvenca).

Species	P	F (%)	Species	P	F (%)
Juniperus phoenicea ssp. *lycia*	80	64.5	*Arctotheca calendula*	29	23.4
Retama monosperma	69	55.6	*Lotus corniculatus*	28	22.6
Galactites elegans	52	41.9	*Silene gallica*	26	20.9
Ammi majus	45	36.3	*Ononis spinosa*	25	20.2
Rumex bucephalophorus	44	35.5	*Solanum sodomaeum*	25	20.2
Ephedra fragilis	42	33.9	*Prasium majus*	25	20.2
Anagallis arvensis	42	33.9	*Ammophila arenaria*	24	19.3
Fumaria ouazzanensis	41	33.1	*Torilis nodosa*	23	18.5
Clematis cirrhosa	38	30.6	*Mercurialis annua*	23	18.5
Olea europaea	35	28.2	*Achyranthes sicula*	23	18.5
Malva sylvestris	35	28.2	*Plantago lagopus*	23	18.5
Phillyrea angustifolia	33	26.6	*Urtica membranacea*	23	18.5
Cerinthe major	33	26.6	*Arisarum vulgare*	22	17.7
Hordeum murinum	32	25.8	*Papaver rhoeas*	21	16.9
Emex spinosa	32	25.8	*Parietaria mauritanica*	20	16.1
Daucus carota	32	25.8	*Asparagus aphyllus*	20	16.1
Lagurus ovatus	30	24.2	*Paronychia argentea*	20	16.1
Pistacia lentiscus	29	23.4	*Smyrnium olusatrum*	20	16.1
Chamaerops humilis	29	23.4	*Sonchus oleraceus*	19	15.3

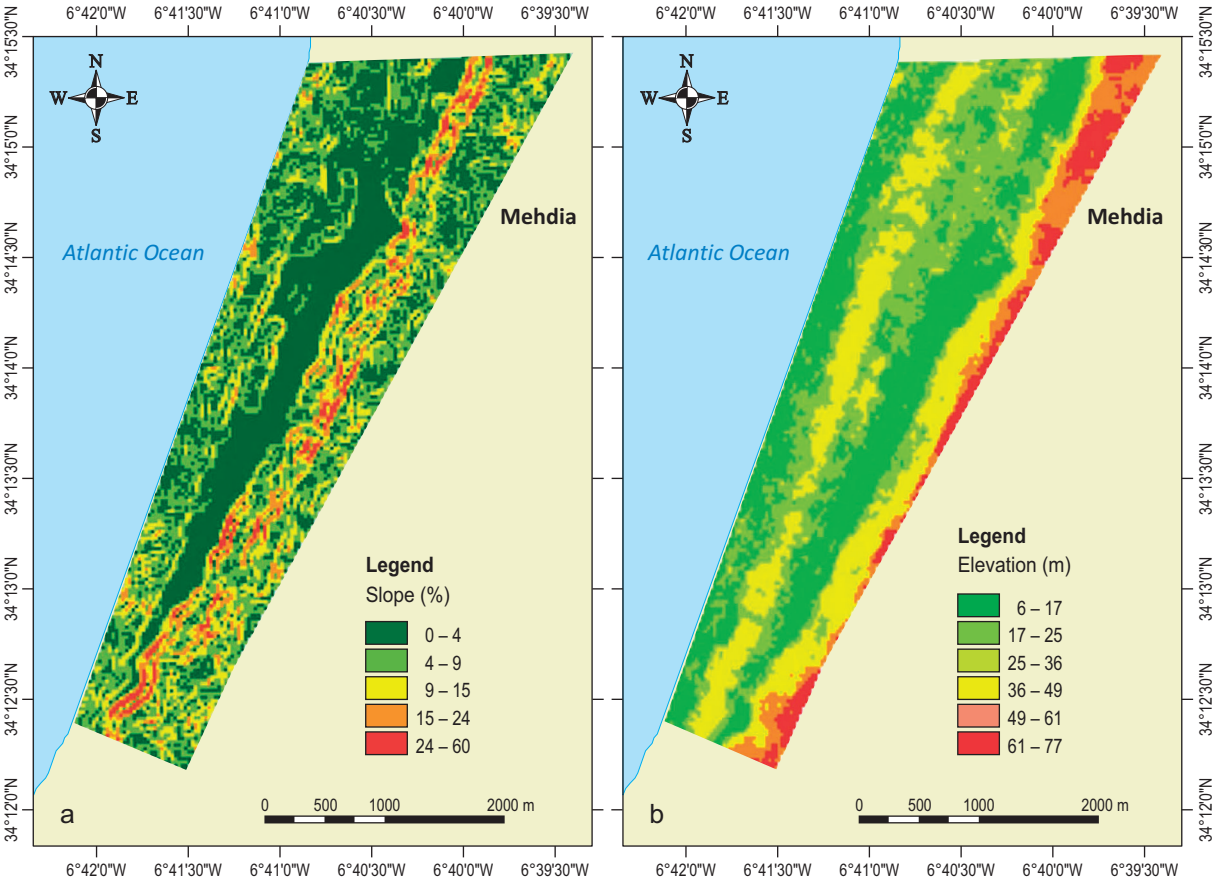

Figure 3: Maps of slope (a) and elevation (b) classes.

Slika 3: Karta razredov naklona (a) in nadmorske višine (b).

Floristic analysis by correspondence factorial analysis

The results of correspondence factorial analysis of all the relevés and the most important species recorded across the study area are shown in Table 3, in which we have taken the first two factorial axes, 1 and 2.

Table 3: Eigenvalues and percentages of inertia of the first factorial axes of correspondence factorial analysis.
Tabela 3: Graf lastnih vrednosti in odstotki inercije prvih faktorskih osi v korespodnenčni faktorski analizi.

Component	Initial eigenvalues			Extraction sum of squares of selected factors		
	Total	% of variance	% cumulated	Total	% of variance	% cumulated
1	11.169	7.300	7.300	11.169	7.300	7.300
2	9.165	5.990	13.290	9.165	5.990	13.290

Eigenvalues

The eigenvalues and inertia rates are relatively high for the first axis and become low and almost constant from the eighth axis onwards (Figure 4). The first two axes explain 13.29% of the variation.

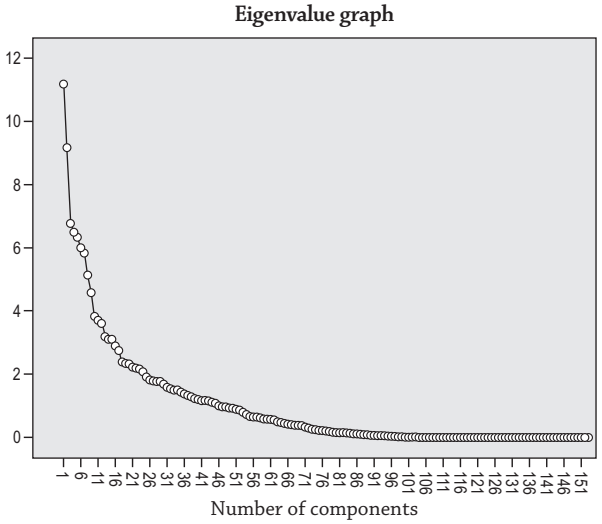

Figure 4: Eigenvalue plot (152 species/124 relevés) at the Sidi Boughaba Biological Reserve.
Slika 4: Lastne vrednosti (152 vrst/124 popisov) v rezervatu Sidi Boughaba.

Meaning of the factorial axes

The correspondence factorial analysis allowed four clusters to be distinguished (Figure 5). In the habitat delimited by the right side of axis 1, a group of *Euphorbia paralias* and *Ammophila arenaria* clearly stands out. This group belongs to the plant formations of the white sand dunes. Another group, characterized by *Populus alba* and *Pteridium aquilinum*, appears to be strongly linked to axis 1. These relevés were recorded on unconsolidated and consolidated fixed sand dunes. The third group that stands out is found in the habitat delimited on the left side of axis 1 and axis 2; it was observed on unconsolidated and consolidated fixed sand dunes. The last group, dominated by *Solanum sodomaeum* and *Retama monosperma*, was developed on the edges of the juniper forest, near cultivated areas.

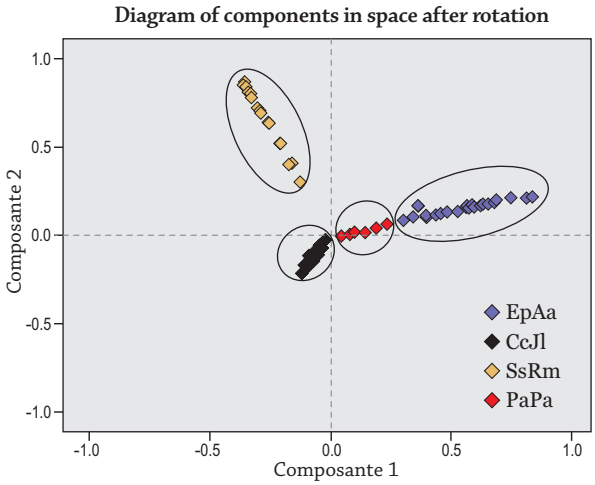

Figure 5: Factorial plan of the F1 and F2 axes of the correspondence factorial analysis of the relevés in the Sidi Boughaba Biological Reserve (152 species/124 relevés).
Slika 5: Faktorski diagram osi F1 in F2 korespondenčne faktorske analize popisov iz rezervata Sidi Boughaba (152 vrst/124 popisov).
Legend (**Legenda**): EpAa *Euphorbio paralie-Ammophiletum arenariae*, CcJl- *Clematido cirrhosae-Juniperetum lyciae*, SsRm *Solano sodomaeum-Retametum monospermae*, PaPa- *Pteridio aquilinum-Populetum albae*.

In relation to axis 1, the species on the right side form two closely related groups: group I formed by *Euphorbia paralias* and *Ammophila arenaria* occupying the mobile white dunes and group II characterised by *Populus alba* and *Pteridium aquilinum* from the bottom of the interdunal depression. On the negative side, group III was characterised by *Juniperus phoenicea* ssp. *lycia* and *Clematis cirrhosa* and was located on consolidated grey dunes, while group IV, characterised by *Solanum sodomaeum* and *Retama monosperma*, is far from this axis and is much more linked to axis 2.

It seems that axis 1 represents the soil type factor, since group I is made up of psammophilous species, group II of hydrophilous species and group III of matorral species. In relation to axis 2, group IV, dominated by *Retama monosperma* and nitrophilous species, indicates that factor 2 corresponds to anthropization.

Determination of phytosociological groups

The bottom-up hierarchical clustering method applied to the 124 relevés provided a hierarchical tree (Figure 6). The shape of the graph allowed us to divide the relevés into nine groups.

The nine groups are also presented in the phytosociological tables (Tables 4–12). The factorial study of the vegetation of the Sidi Boughaba Biological Reserve allowed us to distinguish four plant communities (Figure 5), which we further divided into 9 units or plant groups by hierarchical classification (Figure 6).

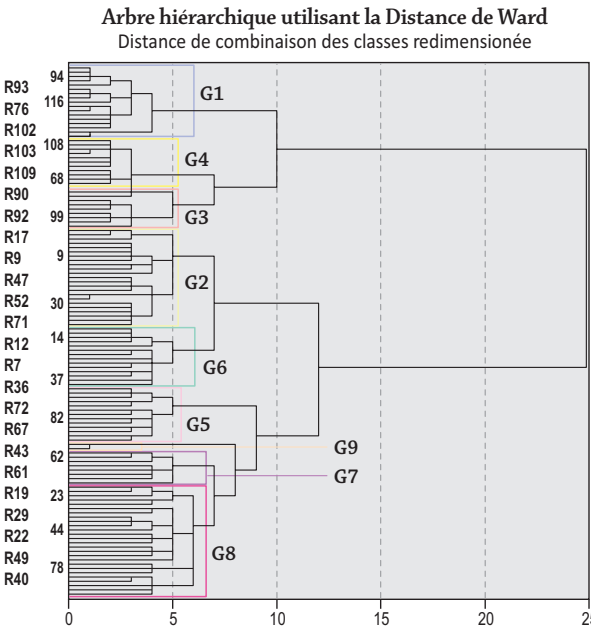

Figure 6: Dendrogram of the hierarchical relevé classification.
Slika 6: Dendrogram hierarhične klasifikacije popisov.

Discussion

The vegetation of the study area consists of three main groups of plant communities. Above the tidal zone, on the mobile sand dunes, the vegetation of *Ammophila arenarea*, *Euphorbia paralias* and other psammophilous species, is sparse. The dune ridges that follow have increasingly consolidated substrates eastwards; they are colonized by communities of species adapted to each type of environment, with the ultimate evolution of these communities leading to juniper forest. This is generally found in a matorralized state but it can tend towards a state of equilibrium on stabilized gray dunes where the soil is well developed. The interdune depressions are occupied by typical hygrophilous vegetation, *Populus alba* accompanied by *Pteridium aquilinum* and other hygrophilous species. The two main factors that determine the distribution of vegetation in the study area are the type of soil and anthropization; the first factor is predominant, being the result of zonation from the sea, while the second factor has only recently begun to take hold. Our synthesis thus allowed the distinction of 9 plant groups.

Group 1 (*Ammophila arenaria*, *Euphorbia paralias*) (Table 4)

This plant community corresponds to the first vegetation belt (Habitat type 1), which appears on the mobile dunes. It contains perennial pioneer vegetation of the upper beach to *Polygonum maritimum, Medicago marina, Otanthus maritimus* and *Ipomoea stolonifera.* It is subject to the effects of strong winds and settles on sandy mineral substrates. A few specimens of *Acacia cyanophylla* and *Acacia cyclops* can still be observed at the eastern limit of the territory of this phytosociological group. These two species were originally introduced to fix the mobile dunes and are now gradually being eliminated by the expanding native vegetation. The stands are dominated by *Ammophila arenaria* and *Euphorbia paralias*. This made it possible to define the association *Euphorbio paraliae-Ammophiletum arenariae*, which belongs to *Euphorbio paraliae-Ammophiletea australis* Géhu & Géhu-Franck 1988 corr. Géhu in Bardat *et al.* 2004, *Ammophiletalia australis* BR.-Bl. 1933, *Ammophilion arenariae* (Tüxen in Br.-Bl. & Tüxen 1952) Géhu 1988. This association is found across Morocco in the same geographical areas as coastal red juniper formations (Benabid, 2000).

Group 2 (*Juniperus phoenicea*, *Clematis cirrhosa*) (Table 5)

The landscape in the study area is dominated by *Juniperus phoenicea*, which is the most widespread tree species. It occupies various topographic positions and is mainly associated with *Clematis cirrhosa*, *Ephedra fragilis*, *Phillyrea angustifolia*, *Olea europaea*, *Retama monosperma* and *Chamaerops humilis.* The plant community is located on the western slopes of the two consolidated dunes and on the northern parts of the second unconsolidated grey dune and can be found in places in the form of practically impenetrable groves. It is a climax community forming a plant association called *Clematido cirrhosae-Juniperetum lyciae* by Barbera, Quézel & Rivas-Martinez (1981), which belongs to the following higher phytosociological units: *Quercetea ilicis* Br.-Bl., 1947, *Pistacio-Rhamnetalia alaterni* Rivas-Martinez 1975 and *Juniperion-lyciae* Barbera, Quézel & Rivas-Martinez, 1981. Benabid (2000) describes this association as characteristic of maritime dunes in subhumid bioclimates and the thermo-mediterranean vegetation stage.

Group 3 (*Juniperus phoenicea*, *Clematis cirrhosa*, *Ephedra fragilis*) (Table 6)

It is a sparse tree formation with low cover. The species that characterize it are *Juniperus phoenicea* and *Ephedra fragilis.* It occupies the fixed sandy dunes forming the second vegetation belt after the tidal zone. The substrate is sandy on deep sand enriched with organic matter. This community can be described as a subassociation *Clematido cirrhosae-Juniperetum lyciae ephedretosum fragilis* subass. nov.; it can only be found on completely fixed and stabilized dunes and can be considered to be close to a climax community. Indeed, a balance would have been established between the vegetation and the environmental conditions because of a fence installed during the last 50 years.

Group 4 (*Juniperus phoenicea*, *Clematis cirrhosa*, *Phillyrea angustifolia*) (Table 7)

This phytosociological group, characterized by three species, is the subassociation *Clematido cirrhosae-Juniperetum lyciae phillyreetosum angustifoliae* subass. nov. It occupies fixed sandy dunes, forming the second vegetation belt, on substrates with a sandy texture and deep sand enriched with organic matter. *Phillyrea angustifolia,* being less demanding for organic matter and water than *Pistacia lentiscus*, has been able to occupy these moderately moist sandy textured soils, where it is relatively abundant in association with red juniper, *Retama monosperma* and *Ephedra fragilis*. It is a species that is resistant to soil water deficit. The plant community is the result of a fire in 1973 that destroyed part of the juniper climax community that was developing on the fixed and unconsolidated grey dune. Thanks to its great resistance to fire, *Phillyrea angustifolia* was able to establish itself together with the remaining sparse stands of juniper and of some species characteristic of the climax community. The presence of *Clematis cirrhosa*, even in the form of rare plants, testifies to the forest atmosphere of the *Clematido cirrhosae-Juniperetum lyciae* association. We propose the newly described subassociation *Clematido cirrhosae-Juniperetum lyciae phillyreetosum angustifoliae* subass. nov. It is a regeneration community developed on dunes. Observation showed a weak presence of *Pistacia lentiscus* with an abundance of less than 5% in the territory of the subassociation thus defined; before the fire, this species formed a degradation community according to Benabid (1982).

Group 5 (*Juniperus phoenicea, Clematis cirrhosa, Olea europea*) (Table 8)

In this group, stands of oleaster are largely located on the west-facing slopes of the first consolidated dune and on the less humid mid-western slopes of the second consolidated dune, on superficial soils and dune sandstone. Oleaster is more frequently mixed with red juniper on dune sandstones, while *Phillyrea angustifolia* is mixed with red juniper on deep sands. *Olea europaea* is a very plastic species, indifferent to the nature of the substrate (Atbib, 1983). This is the third subassociation, for which we propose the name *Clematido cirrhosae-Juniperetum lyciae oleetosum europeae* subass. nov. *Olea europaea* is relatively abundant, especially in the eastern zone (consolidated dune) of the reserve. Large, well-developed and physiologically vital individuals of *Olea europaea* were observed, associated with *Juniperus phoenicea*, *Retama monosperma*, *Pistacia lentiscus* and *Clematis cirrhosa*, which is the characteristic climax species.

Group 6 (*Juniperus phoenicea*, *Clematis cirrhosa*, *Retama monosperma*) (Table 9)

This is the fourth subassociation, which we would call *Clematido cirrhosae-Juniperetum lyciae retametosum monospermae* subass. nov.. *Retama monosperma* is a substrate-independent species, occurring on deep calcareous sands, deep sandy soils and superficial dune sandstones. This subassociation occupies the peripheral parts of the northern zone and the central part of the association *Clematido cirrhosae-Juniperetum lyciae*. It is an old plant community with aged and decaying specimens of *Juniperus phoenicea*. *Clematis cirrhosa* is still present with a high abundance-dominance ranging from 20% to 45%. It is a plant community strongly invaded by *Retama monosperma,* whose cover can reach 100%. This phytosociological group therefore represents the beginning of matorralisation of plant formation. This is an evolutionary state of the vegetation marked by sparsely-spaced, poorly-developed trees, and is found in areas with a Mediterranean climate.

Group 7 (*Juniperus phoenicea*, *Retama monosperma*, *Chamaerops humilis*) (Table 10)

This plant community is presented as the fifth subassociation, with the name *Clematido cirrhosae-Juniperetum lyciae chamaeropetosum humilis* subass. nov. It is a highly degraded phytosociological group that is beginning to be infiltrated by *Chamaerops humilis,* with a tree cover of no more than 25% and a shrub cover of no more than 50%. It derives from the *Juniperus phoenicea*, *Clematis cirrhosa* and *Retama monosperma* phytosociological group, and occupies the top of the dune system in a continuous strip from north to south, marking the transition and limit between the *Juniperus phoenicea* formation and the crops to the east. It is also found throughout most of the interdune furrow, on deep, dry, sandy soils. The species observed in the study area are characteristic of *Quercetea ilicis*; thermophilic elements such as *Olea europaea*, *Chamaerops humilis*, *Pistacia lentiscus, Juniperus phoenicea* and *Retama monosperma*.

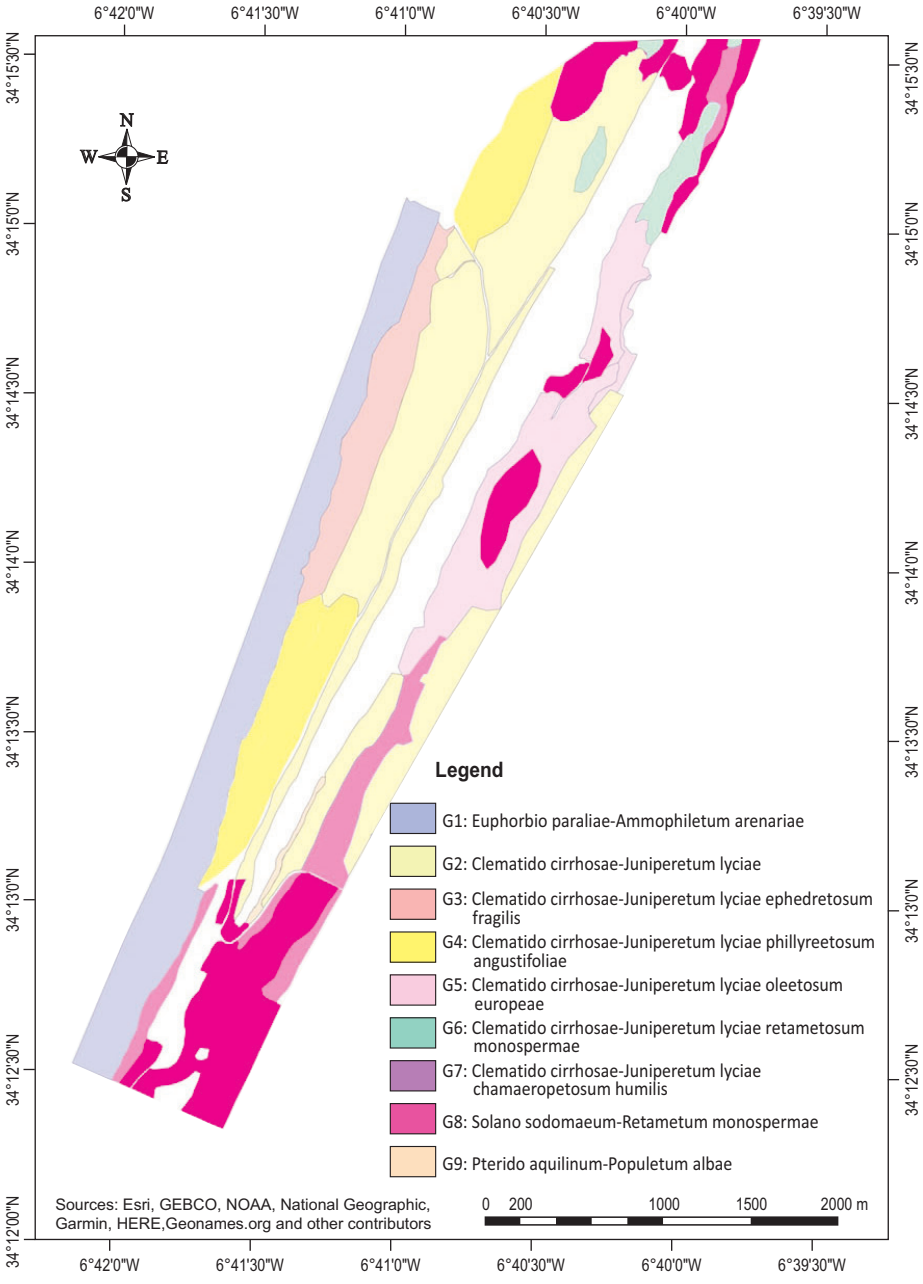

Figure 7: Vegetation map of plant communities in the Sidi Boughaba Biological Reserve.
Slika 7: Vegetacijska karta rastlinskih združb v rezervatu Sidi Boughaba.

Group 8 (*Retama monosperma, Chamaerops humilis*, *Solanum sodomeum*) (Table 11)

This plant community is a highly degraded state of *Solano-Retametum*, with a total absence of *Juniperus phoenicea*. This matorral, with *Retama monosperma*, can therefore be considered to be a plant association for which the name *Solano sodomaeum-Retametum monospermae* is proposed. In fact, this association has already been described in an internal report by Jdi et al. (1987) and is validly published for the first time in this work. It mainly occupies the wide furrow separating the two consolidated dune systems, the northern part of the "merja", the transition zone between the juniper formation and the cultivated land to the east and an extensive area to the south of the reserve. It belongs to the same syntaxa as *Clematido cirrhosae-Juniperetum lyciae*, since it occupies its territory and derives from it by extensive degradation. The absence of *Juniperus phoenicea* and the low representation of the characteristic climax species, replaced by annual and nitrophilous plants, are the result of a strong anthropization of the environment.

Group 9 (*Populus alba*, *Pteridium aquilinum*) (Table 12)

This is a hygrophilous plant community and is linked to the hydromorphic soil type at the south-eastern end of the "merja". This arboreal vegetation can be distinguished in the study area by its color and density of leaves, which varies according to the season, thus bringing variability to the landscape. The phytosociological group observed in the study area would therefore be a plant association designated *Pteridio aquilinum-Populetum albae* ass. nov. *Populetalia albae* represents hygrophilic communities, the most characteristic of which are *Phillyrea angustifolia*, *Populus alba*, *Juncus acutus*, *Pteridium aquilinum*, *Adiantum capillus-veneris* and other subordinate taxa.

The nine plant communities are classified as follows in the syntaxonomical system:

Ammophiletea Br.-Bl. et Tx. ex Westhoff et al. 1946
Ammophiletalia
Ammophilion arenariae (Tüxen in Br.-Bl. & Tüxen 1952) Géhu 1988
1. *Euphorbio paraliae-Ammophiletum arenariae* Géhu & Géhu-Franck 1988 corr. Géhu 2004

Quercetea ilicis Br.-Bl. 1947
Pistacio-Rhamnetalia alaterni Rivas-Martinez 1975
Juniperion-lyciae, Barbero, Ouézel and Rivas-Martinez 1981
2. *Clematido cirrhosae-Juniperetum lyciae* Barbero, Ouézel & Rivas-Martinez 1981
2a. *Clematido cirrhosae-Juniperetum lyciae typicum*
2b. *Clematido cirrhosae-Juniperetum lyciae ephedretosum fragilis* subass. nov. hoc loco
Holotypus: Table 6, relevé 96
2c. *Clematido cirrhosae-Juniperetum lyciae phillyreetosum angustifoliae* subass. nov. hoc loco
Holotypus: Table 7, relevé 84
2d. *Clematido cirrhosae-Juniperetum lyciae oleetosum europeae* subass. nov. hoc loco
Holotypus: Table 8, relevé 34
2e. *Clematido cirrhosae-Juniperetum lyciae retametosum monospermae* subass. nov. hoc loco
Holotypus: Table 9, relevé 89
2f. *Clematido cirrhosae-Juniperetum lyciae chamaeropetosum humilis* subass. nov. hoc loco
Holotypus: Table 10, relevé 38
3. *Solano sodomaeum-Retametum monospermae* Jdi in Challi et al. ass. nov.
Holotypus: Table 11, relevé 33

Querco roboris-Fagetea sylvaticae Br.-Bl. & J. Vlieger in J. Vlieger 1937
Populetalia albae Br.-Bl. ex Tchou 1948
Populion albae Braun-Blanq. ex Tchou 1949
4. *Pterido aquilinum-Populetum albae* ass. nov. hoc loco
Holotypus: Table 12, relevé 74

The study carried out in the Sidi Bougnaba biological reserve made it possible to define plant groups, to specify their phytosociological affiliation and to delimit their area of distribution thanks to the geographical coordinates taken for each relevé. This allowed the creation of a vegetation map (Figure 7) that reflects the ecological conditions of the environment, and several plant communities may belong to the same plant formation (physiognomy) and the same vegetation series.

Conclusions

The Sidi Boughaba Biological Reserve is a wetland that is distinguished by both its fauna and flora. Statistical analyses of the data collected by the numerical method based on correspondence factorial analysis and then on a hierarchical ascending classification, allowed the definition of nine phytosociological groups, including four associations and five subassociations. The association considered to be climactic in the area is *Clematido cirrhosae-Juniperetum lyciae* Barbero et al. 1981. Depending on the environmental conditions and the impact of anthropization, stages of degradation derived from the climax were established. They range from matorralised structures such as the subassociations: *Clematido cirrhosae-Juniperetum lyciae ephedretosum fragilis*, *Clematido cirrhosae-Juniperetum lyciae phillyreetosum angustifoliae*, *Clematido cirrhosae-Juniperetum lyciae oleetosum europeae*, *Clematido cirrhosae-Juniperetum lyciae retametosum monospermae* and *Clematido cirrhosae-Juniperetum lyciae chamaeropetosum humilis* to very degraded or even completely therophytised structures that are heavily infiltrated by nitrophilous species. The present study thus made it possible to propose five subassociations and one new association. The phytosociological groups thus defined belong to three phytosociological classes: *Ammophiletea*, *Quercetea ilicis* and *Querco roboris-Fagetea sylvaticae*. The results obtained show that the rich and remarkable biodiversity of the study area is strongly impacted by anthropozoic factors, even within the reserve. It is therefore essential to safeguard this heritage.

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References

Atbib, M. (1977). *Etude phyto-écologique de la réserve biologique de Mehdia (littoral atlantique, Maroc)*. [Thèse de 3éme cycle, Université des Sciences et Techniques de Montpellier].

Atbib, M. (1983). Phytoecological study of the biological reserve of Mehdia (Atlantic coast of Morocco) -2- The vegetation of the dune environment. *Bulletin de l'Institut Scientifique, Rabat, suppl., 5*, 73–133.

Aubert, G. (1965). Classification des sols. Tableaux des classes, sous-classes, groups et sous-groupes de sols utilisés par la section de pédologie de l'O.R.S.T.O.M. *Cahiers O.R.S.T.O.M. Pédol, Paris*, *3*(4), 89–90.

Bathaoui, F. (2001). *Biodiversité spécifique végétale de la réserve biologique de Sidi Boughaba, Mehdia (Maroc)*. Mémoire de 3éme Cycle, Option Ecologie et Gestion des Ressources Naturelles, ENFI Salé.

Benabid, A. (1982). *Phytoecological, biogeographical and dynamic studies of sylvatic associations and series in the Western Rif (Morocco)*. [Thesis Es-Sciences, University of Aix-Marseille III].

Benabid, A. (2000). *Flora and ecosystems of Morocco. Evaluation and preservation of biodiversity*. Ed. Ibis Press.

Braun-Blanquet, J. (1964). Pflanzensoziologie. Grundzüge der Vegetationskunde. 3. Aufl. Springer-Verlag. https://doi.org/10.1007/978-3-7091-8110

Challi, D., Dahmani, J., Jdi, E.H., & Belahbib, N. (2021). Evolution of climatic conditions between 1982 and 2016 in the Sidi Boughaba biological reserve (Kénitra, Morocco). *Journal of Basic and Applied Research International*, *27*(5), 18–28.

Cherkaoui, I., Dakki, M., Lahrouz, S., & Hanane, S. (2013). Dix années de suivi des anatidés nicheurs sur le lac de Sidi Boughaba (Nord-ouest Marocain) : Situation, tendances d'évolution et perspectives de recherche. *Revue d'Ecologie (La Terre et La Vie)*, *68*, 167–180.

Duchauffour, Ph. (1982). *Pedology. Pedogenesis and Classification*. Ed. George Allen and Unwin.

Environmental Systems Research Institute (ESRI). (2015). ArcGIS Release 10.3. Redlands, CA.

Fennane, M. (2003). Phytosociology of Moroccan tetraclinae. *Scientific Institute Bulletin*, *29*(1), 87–106.

Fennane, M., Ibn Tattou, M., Mathez, J., Ouyahya, A., & El Oualidi, J. (1999). *Flore Pratique du Maroc. Manuel de détermination des plantes vasculaires. Volume 1*. Travaux de l'Institut Scientifique, Série Botanique.

Fennane, M., Ibn Tattou, M., Mathez, J., Ouyahya, A., & El Oualidi, J. (2007). *Flore Pratique du Maroc. Manuel de détermination des plantes vasculaires. Volume 2*. Travaux de l'Institut Scientifique, Série Botanique.

Fennane, M., Ibn Tattou, M., & El Oualidi, J. (2014). *Flore Pratique du Maroc. Manuel de détermination des plantes vasculaires. Volume 3*. Travaux de l'Institut Scientifique, Série Botanique.

Jdi, E.H., Morsli, A., Faiqi, M., & Aafi, A. (1987). *Contribution to the phytodynamic, phytosociological and cartographic study of the plant groups of the dune environment of Mehdia (Atlantic coast, Morocco)*. [Research thesis, ENFI-Salé].

IBM Corp. (2010). IBM SPSS Statistics for Windows, Version 19.0. Armonk, NY: IBM Corp. https://www.ibm.com/products/spss-statistics

Maarel Van Der, E. (1979). Transformation of cover-abundance values in phytosociology and its effects on community similarity. *Vegetatio, 39*(2), 97–114. http://dx.doi.org/10.1007/BF00052021

Meddour, R. (2010). *Bioclimatologie, phytogéographie et phytosociologie en Algérie. Exemple des groupements végétaux forestiers et pré-forestiers de la Kabylie*. [Thèse de Doctorat, Option Foresterie, Université Mouloud Mammeri, Tizi-Ouzou].

Meinard, Y., & Thébaud, G. (2019). Syntaxonomic identification in the management and/or restoration of natural areas in France: for or against? *Nature*, 6, 165–173. http://revue-naturae.fr/2019/6

Theurillat, J.P., Willner, W., Fernández-González, F., Bültmann, H., Čarni, A., Gigante, D., Mucina, L., & Weber, H. (2021). International code of phytosociological nomenclature. *Applied vegetation science*, 24(1), p.e12491. https://doi.org/10.1111/avsc.12491

Table 4 (Tabela 4): *Euphorbio paraliae-Ammophiletum arenariae* Géhu & Géhu-Franck 1988 corr. Géhu 2004.

RELEVÉ NUMBER	R76	R94	R95	R98	R101	R102	R105	R106	R110	R114	R115	R116	R117	R118	R119	R120	R121	
Coordinate Lat. North Long.West	-6.6988 34.2084	-6.6841 34.2428	-6.6851 34.2401	-6.6830 34.2428	-6.6820 34.2473	-6.6817 34.2482	-6.6820 34.2464	-6.6776 34.2410	-6.6819 34.2437	-6.6830 34.2446	-6.6914 34.2238	-6.6882 34.2301	-6.6851 34.2392	-6.6893 34.2283	-6.6872 34.2319	-6.6872 34.2337	-6.6860 34.2356	
Station	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	
Elevation (m)	20	20	26	18	71	33	31	26	54	22	36	61	22	24	20	66	20	Pr
Orientation	N	W	W	WS	N	N	N	N	N	N	N	N	N	N	N	N	N	
Slope (%)	0	3	5	0	1	14	6	13	5	26	39	5	1	7	7	5	0	
Soil	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	i	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association																		
Ammophila arenaria	3	3	4	4	1	2	3	3	4	3	4	2	3	3	3	4	4	17
Euphorbia paralias	2	3	2		1		2	2	1		2	2	3	4	3	3	3	14
Otanthus maritimus			2	3			2	2				2	2	3	2			8
Medicago marina	1				2	2	2		3				2			3		6
Polygonum maritimum	4		3	3			2		2							2		6
Ipomoea stolonifera		4			2		3			4	2						4	6
Lotus creticus		3	3	2														3
Cakile maritima			3							1				2				3
Salsola kali										1			2					2
Eryngium maritimum			2															1
Differential species																		
Lycium europeaum						1												1
Ephedra fragilis												2						1
Tamarix gallica										2								1
Hieracium tomentosum			+															1
Galactites elegans				3								1						2
Riechardia tingitana			3	4														2
Pseudorlaya pumila				1					1									2
Solanum sodomeum				+														1
Acacia cyanophylla									2									1
Carpobrotus edulis										2								1

Table 5 (Tabela 5): *Clematido cirrhosae-Juniperetum lyciae* Barbero, Ouézel and Rivas-Martinez 1981

RELEVÉ NUMBER	R80	R82	R65	R100	R59	R21	R61	R47	R48	R70	R58	R66	R69	R63	R64	R68	R51	R52	
Coordinate Lat. North Long. West	-6.6911 34.2201	-6.6892 34.2229	-6.6743 34.2438	-6.6819 34.2446	-6.6701 34.2537	-6.6734 34.2358	-6.6712 34.2510	-6.6696 34.2429	-6.6700 34.2438	-6.6814 34.2358	-6.6701 34.2528	-6.6776 34.2428	-6.6760 34.2428	-6.6722 34.2492	-6.6744 34.2456	-6.6835 34.2322	-6.6711 34.2483	-6.6664 34.2502	
Station	3	3	4	1	4	13	4	11	18	4	4	4	4	4	4	4	4	4	
Elevation (m)	20	22	67	48	32	11	72	18	53	56	25	70	20	28	50	22	27	32	Pr
Orientation	S	W	N	WS	S	NE	N	S	S	S	E	N	S	N	N	N	S	S	
Slope (%)	2	6	6	36	17	4	6	0	5	8	6	5	1	2	27	20	8	13	
Soil	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association																			
Juniperus phoenicea	2	2	4	2	2	3	3	2	2	3	3	3	2	3	1	3	2	4	18
Clematis cirrhosa	3	2	3	2	2	3	3	3	4	4	3	3	4	4	4	3	3	4	18
Rubia peregrina			1			1		2	2	4				3					7
Fumaria ouazzanensis		2		3			2								3				5
Ononis natrix	3	2					3						3						4
Bryonia dioica	4	+																	2
Smilax aspera	2														2				2
Limonium sinuatum						1													1
Clematis flammula							2												1
Differential species of the association																			
Phillyrea angustifolia	1	+	+	1							2	1	2	+	2	3			10
Ephedra fragilis	1	1	1	+	2					1		+	+			+			9
Prasium majus	2		4	3	3						3	4	3	3					9
Olea europaea	+	1						+	1	1	+	+	1						8
Anagalis arvensis	4		3		3	2	3						3		3				8
Ononis spinosa	3	2	2							4	4		5	4					8
Retama monosperma	2	2	2	+	2	2	1												7
Rumex bucephalophorus	4	2			5	1	5				2			5					7
Papaver rhoeas	3	+				2				2			2						7
Lathyrus clymenum			1							4	3	3	4	4	3				7
Arisarum vulgare			3		3	3			2				3		3				6
Jasione montana			3				3			3	3	3	3						6
Pistacia lentiscus				+		2				1				+	1				5
Silene gallica			1		3		3				3								5
Chamaerops humilis					2	1								2	2				4

RELEVÉ NUMBER	R80	R82	R65	R100	R59	R21	R61	R47	R48	R70	R58	R66	R69	R63	R64	R68	R51	R52	Pr
Asparagus albus	2				2	1					2								4
Geranium purpureum			1			2								3	2				4
Fedia pallescens						1	2				2			2					4
Galium aparine		2		1													2	3	4
Lantana camara					2											4			2
Asparagus aphyllus															3				1
Juncus acutus									3										1
Verbascum virgatum							4												1
Lycium europeaum				+															1
Tuberaria guttata											2								1
Lobularia maritima													4						1
Tamarix gallica								+											1
Coronilla repanda											2								1
Gladiolus communis							3												1
Arenaria mauritanica							3												1
Other species																			
Cerinthe major	3	1	3			3	3			3	3		3		3				9
Lagurus ovatus	5				1	4		3			2				3		5	3	9
Galactites elegans	3	1	2	3	3	1	3						3						8
Hordeum murinum	5	5						5	5	4				5					7
Lotus corniculatus			1		3					4			4	3					6
Parietaria mauritanica	5		2			3	3				1								6
Ammi majus	3	1				2			4						3				6
Malva sylvestris	3							3	4	1					2				6
Daucus carota			3	2		2	3							3	2				6
Trifolium campestre		2					3				1			4	2				5
Achyranthes sicula						1			2					4	2				5
Anisantha sterilis								5				4		5				3	5
Plantago lagopus		2	1							1			2						4
Arctotheca calendula	3			3				3		4									4
Hypochaeris glabra	3			4								4							4
Centranthus calcitrapae			1			2								3					4
Smyrnium olusatrum		1			2	+	2												4
Calendula arvensis	2	2								4			4						4
Trisetaria panicea					5		3				3				2				4
Lolium perenne		3			5		5												4

RELEVÉ NUMBER	R80	R82	R65	R100	R59	R21	R61	R47	R48	R70	R58	R66	R69	R63	R64	R68	R51	R52	Pr
Torilis nodosa								3	4					4					3
Geranium molle						3			2										3
Vicia lutea						1											1	2	3
Centaurea pullata					3									4	3				3
Vicia sativa							4		2		4								3
Medicago polymorpha	3	1													2				3
Urtica membranacea		3		4		2								3	4				3
Parentucellia viscosa					2		4				1								3
Dipcadi serotinum					3		4				2								3
Euphorbia terracina					2									3	4				3
Pseudorlaya pumila		1		1							1								3
Phagnalon saxatile			1	1								4							3
Misopates calycinum						1								3					2
Emex spinosa	2												4						2
Evax pygmaea	3										1								2
Paronychia argentea					2		2												2
Vicia villosa	3					2											2	2	2
Scrophularia auriculata																	2	3	2
Urospermum picroides								2	2										2
Erigeron floribundus																	2	2	2
Linum strictum			3		5														2
Oxalis pes-caprae														3	1				2
Astragalus boiticus			3							1									2
Urtica urens															2				1
Biscutella laevigata						2													1
Anacyclus clavatus	2																		1
Urtica dioica								2											1
Avena sterilis						1													1
Mercurialis annua														1					1
Lupinus angustifolius										3									1
Astragalus hamosus	3																		1
Hypochaeris radicata							4												1
Delphinium pubescens							4												1
Erodium ciconium										4									1
Trisetum flavescens					4														1
Agropyron junceum						3													1

RELEVÉ NUMBER	R80	R82	R65	R100	R59	R21	R61	R47	R48	R70	R58	R66	R69	R63	R64	R68	R51	R52	Pr
Phleum pratensis						1													1
Sonchus oleraceus									3										1
Echium plantagineum										2									1
Rumex pulcher						+													1
Hymenocarpos circinnatus						2													1
Umbilicus horizontalis						+													1
Linaria supina										3									1
Plantago macrorhiza	3																		1
Trifolium angustifolium									3										1
Sonchus asper											2								1
Solanum nigrum								+											1
Plantago lanceolata							3												1
Bartsia trixago							2												1
Asparagus setaceus															2				1
Rostraria cristata													1						1
Polycarpon tetraphyllum													3						1
Nonea calycina										2									1
Ferula communis		1																	1
Lotus creticus				2															1
Agave americana				+						+									2
Acacia cyanophylla		+															+		2
Eucalyptus gomphocephala							+								+				2
Opuntia ficus indica																3			1
Pinus strobus															+				1
Acacia cyanophylla		+															+		1
Acacia cyclops				+															1

Table 6 (Tabela 6): *Clematido cirrhosae-Juniperetum lyciae ephedretosum fragilis* subass. nov.

RELEVÉ NUMBER	R103	R107	R41	R62	R112	R72	R96	R109	R123	R87	R113	R124	R104	
Coordinate Lat. North Long. West	-6.6797 34.2472	-6.6843 34.2354	-6.6647 34.2502	-6.6723 34.2501	-6.6819 34.2428	-6.6756 34.2477	-6.6840 34.2410	-6.6809 34.2437	-6.6809 34.2446	-6.6897 34.2174	-6.6808 34.2428	-6.6861 34.2374	-6.6809 34.2455	
Station	2	2	11	4	2	4	1	2	2	4	2	1	2	
Elevation (m)	61	21	27	72	57	60	18	24	32	29	62	18	20	Pr
Orientation	N	N	N	N	N	WS	W	N	N	W	N	N	N	
Slope (%)	6	21	15	6	1	31	0	6	31	3,4	1	4	0	
Soil	ii	ii	ii	ii	ii	Ii	ii	ii	ii	ii	ii	ii	ii	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association *Clematido cirrhosae-Juniperetum lyciae*														
Juniperus phoenicea	2	3	1	1	2	3	1	3	1	1	2	1	3	13
Phillyrea angustifolia	1	2				1	+	1	3				2	8
Prasium majus				2			2	1	3	+			1	7
Retama monosperma	+	+	1	1	2								1	6
Fumaria ouazzanensis			1			4	1			2				5
Pistacia lentiscus		1		+				+		+				4
Lycium europeaum	1											2	1	3
Clematis cirrhosa									1				1	2
Bryonia dioica					1									2
Limonium sinuatum			+											1
Osyris quadripartita								2						1
Differential species of the subassociation *Clematido cirrhosae-Juniperetum lyciae ephedretosum fragilis* subass.														
Ephedra fragilis	3	4	2	2	4	2	2	2	4	2	3	1	2	14
Ammophila arenaria							+							1
Polygonum maritimum							2							1
Lotus creticus							2							1
Otanthus maritimus							2							1
Cakile maritima							2							1
Fedia pallescens				2										1
Other species														
Daucus carota			1	3	1					3	1		1	6
Galactites elegans				3			+			2	2			4
Anagalis arvensis			1	3						2				3
Ononis spinosa				3		4				1				3
Emex spinosa			4			1				2				3
Malva sylvestris			1			1				2				3
Cerinthe major						3				1				2
Arctotheca calendula			1				2							2
Plantago lagopus			2	3										2
Anacyclus radiatus						3				3				2
Lolium perenne							3			4				2
Papaver rhoeas			1							1				2
Paronychia argentea			+	2										2
Chamaerops humilis			+	1										2
Erodium cicutarium				3						2				2
Agropyron junceum			1		1									2
Urtica membranacea			3				3							2
Calendula arvensis				4						1				2

RELEVÉ NUMBER	R103	R107	R41	R62	R112	R72	R96	R109	R123	R87	R113	R124	R104	Pr
Trisetaria panicea			1	1										2
Euphorbia terracina				3						2				2
Arisarum vulgare										3				1
Sonchus asper										1				1
Plantago lanceolata										2				1
Pseudorlaya pumila							1							1
Oxalis pes-caprae										1				1
Salvia verbenaca			+											1
Urtica dioica												1		1
Rumex bucephalophorus				1										1
Parietaria mauritanica										1				1
Silybum marianum						2								1
Centaurea pullata				2										1
Hordeum murinum										1				1
Silene gallica				3										1
Echium vulgare				2										1
Lupinus angustifolius			+											1
Vicia sativa			1											1
Lotus corniculatus				1										1
Tolpis barbata				1										1
Hypochaeris radicata				1										1
Smyrnium olusatrum				1										1
Melilotus indicus						3								1
Trisetum flavescens				1										1
Parentucellia viscosa				2										1
Ammi majus										2				1
Linaria maroccana			+											1
Sonchus tenerrimus							2							1
Anacyclus clavatus										2				1
Lantana camara					1									1
Jasione montana						1								1
Lathyrus clymenum						2								1
Armeria mauritanica				3										1
Anisantha tectorum				1										1
Logfia gallica				1										1
Asparagus setaceus										3				1
Phagnalon sexatile						2								1
Nonea calycina						2								1
Opuntia ficus indica						1							1	2
Agave americana						2								1

Table 7 (Tabela 7): *Clematido cirrhosae-Juniperetum lyciae phillyreetosum angustifoliae* subass. nov.

RELEVÉ NUMBER	R79	R83	R86	R39	R57	R67	R81	R72	R84	R85	R90	
Coordinate Lat. North Long. West	-6.6935 34.2165	-6.6882 34.2238	-6.6886 34.2211	-6.6636 34.2520	-6.6734 34.2537	-6.6761 34.2410	-6.6903 34.2211	-6.6756 34.2477	-6.6882 34.2247	-6.6876 34.2225	-6.6809 34.2473	
Station	1	3	3	11	4	4	3	4	3	3	1	
Elevation (m)	29	21	20	24	33	46	26	60	20	20	18	
Orientation	S	W	W	N	N	N	W	WS	W	W	W	Pr
Slope (%)	12	7	0	25	11	5	16	31	0	1	0	
Soil	ii	ii	ii	ii	ii	ii	ii	ii	Ii	ii	ii	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association *Clematido cirrhosae-Juniperetum lyciae*												
Juniperus phoenicea	2	2	2	2	3	3	2	2	+	2	1	11
Ephedra fragilis	1	+	+			+	1	1	1	2	+	9
Fumaria ouazzanensis	1	3		2	2	2		4	2			8
Bryonia dioica	2		2			2	3			1	+	7
Ononis natrix		2	2		3	2	3		3			7
Retama monosperma	1	1	+	2								4
Olea europaea	2				1	+	1					4
Pistacia lentiscus				+	1						+	3
Daucus carota				1	2						1	3
Clematis cirrhosa									2		2	2
Limonium sinuatum				+								1
Smilax aspera		2										1
Differential species of the subassociation *phillyreetosum angustifoliae*												
Phillyrea angustifolia	3	2	2	+	2	2	2	3	3	2	+	11
Prasium majus		+	1						2	+	1	5
Lotus creticus											3	1
Polygonum maritimum											2	1
Ammophila arenaria											+	1
Other species												
Galactites elegans	3	2	3	2	2	2	2		3	2	2	10
Cerinthe major	2	2		1	3	2	2	3	3			8
Lotus corniculatus	1	2	2	3		2	3		2			7
Emex spinosa	3	3	3	1		2	2	1				7
Rumex bucephalophorus	3	3		2	4		3		4			6
Ammi majus	2	2	1	4			2			2		6
Calendula arvensis	3		1		2	1	3					5
Plantago lagopus	2	1		1		1			2			5
Silene gallica		1		1			3		3	+		5
Medicago polymorpha	2				3	1		3			2	5
Arctotheca calendula	3					1				2	2	4
Ononis spinosa	2	2						4	3			4
Mercurialis annua	1	1	1		1							4
Asparagus albus		1		1	+				1			4
Hypochaeris glabra	1		2				3			3		4
Polypogon monspeliensis	2	1					4		5			4
Dipcadi serotinum			1		3				2	2		4
Oxalis pes-caprae			3			1				1		3
Arisarum vulgare	1					1			2			3

RELEVÉ NUMBER	R79	R83	R86	R39	R57	R67	R81	R72	R84	R85	R90	Pr
Hordeum murinum					1	1	4					3
Malva sylvestris				2		1		1				3
Lolium perenne		4					1			1		3
Urtica membranacea		3					1				2	3
Fedia pallescens	1			2	1							3
Pseudorlaya pumila		2								1	1	3
Vicia villosa	1		+				2					3
Anacyclus radiatus						1		3		1		3
Jasione montana			+		1			1				3
Solanum sodomeum				+							+	2
Anagalis arvensis	+									2		2
Smyrnium olusatrum		+			2							2
Chamaerops humilis				+	1							2
Asparagus aphyllus			+	+								2
Lathyrus clymenum						4		1				2
Evax pygmaea		1			1							2
Erodium cicutarium	1			2								2
Astragalus hamosus				2			1					2
Sonchus oleraceus				3	3							2
Rubia peregrina				1		3						2
Sonchus asper				3						3		2
Plantago lanceolata			3							3		2
Lagurus ovatus							1					1
Torilis nodosa							2					1
Parietaria mauritanica				2								1
Trifolium campestre									3			1
Achyranthes sicula				1								1
Lobularia maritima									1			1
Juncus acutus										3		1
Rostraria cristata										+		1
Misopates calycinum					3							1
Scolymus hispanicus				1								1
Papaver rhoeas				+								1
Geranium molle							3					1
Silybum marianum								2				1
Centaurea pullata				+								1
Echium vulgare			2									1
Lycium europeaum											1	1
Hypochaeris radicata						1						1
Melilotus indicus								3				1
Trisetum flavescens					1							1
Echium plantagineum						3						1
Umbilicus horizontalis				+								1
Sonchus tenerrimus											1	1
Ruscus hypophyllum				+								1
Verbascum boerhavii				+								1
Sedum rupestre				1								1
Urospermum picroides						1						1
Solanum nigrum											1	1
Ononis reclinata					2							1

RELEVÉ NUMBER	R79	R83	R86	R39	R57	R67	R81	R72	R84	R85	R90	Pr
Euphorbia terracina							2					1
Helianthemum salicifolium					+							1
Gleditsia triacanthos					1							1
Phagnalon sexatile								2				1
Bromus hordeaceus		2										1
Nonea calycina								2				1
Ferula communis							1					1
Agave american								2			2	2
Opuntia ficus indica								1			1	2

Table 8 (Tabela 8): *Clematido cirrhosae-Juniperetum lyciae oleetosum europeae* subass. nov.

RELEVE NUMBER	R19	R20	R18	R22	R23	R34	R44	R45	R29	R50	
Coordinate Lat. North Long. West	-6.6721 34.2375	-6.6720 34.2366	-6.6761 34.2352	-6.6748 34.2320	-6.6767 34.2292	-6.6732 34.2393	-6.6689 34.2429	-6.6691 34.2446	-6.6697 34.2402	-6.6690 34.2474	
Station	13	11	11	11	11	11	11	11	11	18	
Elevation (m)	17	13	30	16	17	15	20	20	63	68	Pr
Orientation	NW	NW	NW	NW	NW	NW	N	N	S	S	
Slope (%)	5	1	0	13	13	6	9	1	8	6	
Soil	ii	ii	ii	ii	ii	ii	ii	ii	ii	ii	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association *Clematido cirrhosae-Juniperetum lyciae*											
Juniperus phoenicea	3	3	1	3	3	3	2	2	1	2	10
Fumaria ouazzanensis		3	+	2	3	3	3	3	3		9
Retama monosperma	1	1	+	1	1	1	+	1			8
Clematis cirrhosa			1	3	3	3	2	3	2		7
Pistacia lentiscus				1	+	+	3	+	4	1	7
Fedia pallescens				+			1	2	1		4
Prasium majus				2	1				1		3
Limonium sinuatum					+		+		2		3
Ephedra fragilis									+		1
Rubia peregrina		2									1
Bryonia dioica		1									1
Differential species of the subassociation *oleetosum europeae*											
Olea europaea	3	3	5	3	4	4	3	4	3	2	10
Ammi majus	2	1	+	3	2	3	3	4	2		9
Cerinthe major		3		2	3	3		2	1	2	7
Asparagus albus	1	1	+				+	1	1		6
Chamaerops humilis	+		1			1	1	+	1		6
Asparagus aphyllus		2	3					1			3
Other species											
Achyranthes sicula	+	2	2	1	2	+	2	2		1	9
Sonchus oleraceus	+	3	1		4	2		3	3	2	8
Geranium molle	+	1				3		2	2	1	6
Agropyron junceum	4	5	+		3	4			5		6
Lagurus ovatus	+		+				2	5	3		5
Malva sylvestris	1	1		2				3		2	5

RELEVE NUMBER	R19	R20	R18	R22	R23	R34	R44	R45	R29	R50	Pr
Torilis nodosa	+		+	2						2	4
Anagalis arvensis	3			3	3			3			4
Parietaria mauritanica	2	3	2			2					4
Ornithopus sativus	+	1	+				2				4
Tolpis barbata	+		2		3		1				4
Smyrnium olusatrum			+			1		1	2		4
Urtica membranacea			3		3				2	3	4
Rumex bucephalophorus	+				4				3		3
Misopates calycinum					3	1			1		3
Emex spinosa		2			3	3					3
Arisarum vulgare				1		2			2		3
Hordeum murinum			2						3	3	3
Cerastium glomeratum	+		+		3						3
Mercurialis annua		4					3	2			3
Vicia sativa	+			2	2						3
Silene gallica	+		+		2						3
Phleum pratensis	3		r		3						3
Medicago orbicularis	1		1		2						3
Daucus carota					3			1	4		3
Ononis natrix		1		3							2
Avena sterilis	3				3						2
Galactites elegans	3	1									2
Tuberaria guttata		2					1				2
Campanula lusitanica		+							2		2
Ruscus hypophyllum								+	1		2
Briza major (maxima)		3			3						2
Geranium purpureum				3	1						2
Parentucellia viscosa				+			+				2
Calendula arvensis					3						1
Anacyclus radiatus							1				1
Urginea maritima			+								1
Solanum sodomeum			3								1
Verbascum sinuatum							1				1
Evax pygmaea					1						1
Vicia lutea						3					1
Paronychia argentea					2						1
Erodium cicutarium									2		1
Hypochaeris radicata							2				1
Medicago polymorpha				3							1
Echium plantagineum			+								1
Hypochaeris glabra			1								1
Sonchus arvensis									2		1
Ononis spinosa									3		1
Delphinium pubescens					1						1
Erodium ciconium							2				1
Vicia villosa									3		1
Umbilicus horizontalis									1		1
Lactuca virosa				1							1
Allium subhirsutum				+							1
Lipunus micranthus					+						1

RELEVE NUMBER	R19	R20	R18	R22	R23	R34	R44	R45	R29	R50	Pr
Vulpia geniculata					1						1
Anthoxanthum odorutum					2						1
Convolvulus sp.					1						1
Briza minor									2		1
Narcissus tazetta									1		1
Anacyclus clavatus							1				1
Heteranthemis viscidehirta						2					1
Lolium perenne								2			1
Sonchus asper										2	1
Bromus diandrus							3				1
Dactylis glomerata							1				1
Poa pratensis							2				1
Gladiolus italicus								2			1
Anisantha sterilis								2			1

Table 9 (Tabela 9): *Clematido cirrhosae-Juniperetum lyciae retametosum monospermae* subass. nov.

RELEVÉ NUMBER	R27	R34	R43	R44	R89	R35	R42	R54	R61	
Coordinate Lat. North Long. West	-6.6710 34.2375	-6.6732 34.2393	-6.6668 34.2475	-6.6689 34.2429	-6.6669 34.2565	-6.6626 34.2565	-6.6657 34.2493	-6.6691 34.2537	-6.6712 34.2510	
Station	11	11	11	11	5	14	11	4	4	
Elevation (m)	16	15	31	20	29	17	29	64	72	Pr
Orientation	S	NW	N	N	E	N	N	S	N	
Slope (%)	11	6	7	9	9	6	13	2	6	
Soil	ii	ii	ii	ii	Ii	ii	ii	ii	ii	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association *Clematido cirrhosae-Juniperetum lyciae*										
Juniperus phoenicea	2	2	1	2	+	1	2	1	1	9
Clematis cirrhosa	3	3	3	2	3	3	2	+	4	9
Fumaria ouazzanensis		3	3	3	2	3	1	1	2	8
Pistacia lentiscus	1	2		+	+			+		5
Olea europaea	1	2	1	1						4
Limonium sinuatum			1	+		+	1			4
Fedia pallescens				1					2	2
Clematis flammula									2	1
Phillyrea angustifolia					+					1
Differential species of the subassociation *retametosum monospermae*										
Retama monosperma	3	4	4	3	4	4	2	3	4	9
Chamaerops humilis		1	+	1	3		+			5
Asparagus aphyllus					1	1				2
Other species										
Daucus carota	4		4		2	2	3	2	3	7
Rumex bucephalophorus			4		3	1	4	1	5	6
Galactites elegans			1		2	2	1		3	5
Anagalis arvensis			1		2	3	1		3	5
Mercurialis annua			4	1	3	1	1			5
Silene gallica			2		2	1	1		3	5
Emex spinosa		3	2			4	3			4

RELEVÉ NUMBER	R27	R34	R43	R44	R89	R35	R42	R54	R61	Pr
Papaver rhoeas			1		2	3	1			4
Geranium molle	4	3	3				1			4
Solanum sodomeum			+		1	1	+			4
Paronychia argentea					1	2		2	2	4
Malva sylvestris	3		1			3	2			4
Cerinthe major		3			3	2			3	4
Linaria maroccana	1		1			+	1			4
Lolium perenne			1		1		2		3	4
Misopates calycinum		1			2	2				3
Plantago lagopus			3			2	2			3
Verbascum sinuatum			1	1			+			3
Parietaria mauritanica		2				1			2	3
Centaurea pullata	2				3	1				3
Delphinium pubescens					1	2			2	3
Smyrnium olusatrum		1				+			2	3
Sonchus oleraceus		2	3				3			3
Medicago orbicularis			2			3	2			3
Ononis natrix					2			3	3	3
Anacyclus clavatus			1	1			1			3
Reichardia tingitana			1			2	3			3
Cynodon dactylon			2			3	1			3
Bromus diandrus			2	4			1			3
Plantago lanceolata					3			3	3	3
Lotus corniculatus					3	2				2
Vicia lutea		3						2		2
Arisarum vulgare		2				2				2
Erodium cicutarium			3				3			2
Hordeum murinum	1					1				2
Echium vulgare			2				1			2
Hypochaeris glabra			2				3			2
Ammi majus		3		3						2
Lupinus angustifolius			+				+			2
Tolpis barbata	3			1						2
Hypochaeris radicata				2					3	2
Agropyron junceum		2				2				2
Achyranthes sicula		+		2						2
Parentucellia viscosa				+					1	2
Dipcadi serotinum								1	1	2
Anthemis arvensis			1				2			2
Anthyllis vulneraria			1				+			2
Erucastrum gallicum			+				+			2
Medicago truncatula			2				2			2
Amaranthus blitoides			+				+			2
Diplotaxis tenuifolia			2				1			2
Urospermum picroides			+				+			2
Dactylis glomerata				1	+					2
Verbascum virgatum								3	2	2
Ajuga iva					+			2		2
Jasione montana					+				3	2
Torilis nodosa						1				1
Riechardia tingitana					3					1

RELEVÉ NUMBER	R27	R34	R43	R44	R89	R35	R42	R54	R61	Pr
Arctotheca calendula								3		1
Evax pygmaea	3									1
Cerastium glomeratum						+				1
Ornithopus sativus brot				2						1
Hedypnois rhagadioloides								2		1
Tuberaria guttata				1						1
Sherardia arvensis						3				1
Glebionis coronaria	3									1
Asparagus albus				+						1
Vicia sativa									3	1
Lagurus ovatus				2						1
Astragalus hamosus						1				1
Ononis spinosa					2					1
Campanula rapunculus	+									1
Umbilicus rupestris	3									1
Trifolium campestre									3	1
Erodium ciconium				2						1
Medicago polymorpha								3		1
Urtica membranacea	2									1
Umbilicus horizontalis						1				1
Calendula arvensis					1					1
Vulpia geniculata						3				1
Polypogon monspeliensis								2		1
Asphodelus microcarpus	2									1
Bromopsis inermis	2									1
Euphorbia segetalis					2					1
Anacyclus radiatus				1						1
Juncus acutus								3		1
Heteranthemis viscidehirta		3								1
Lantana camara						2				1
Verbascum boerhavii						1				1
Scille maritime						+				1
Herniaria glabra						+				1
Trisetaria panicea									3	1
Poa pratensis				2						1
Nigella arvensis				+						1
Anchusa officinalis								1		1
Ononis reclinata								3		1
Prangos trifida								1		1
Orobanche sanguinea					+					1
Pseudorlaya pumila					2					1
Arenaria mauritanica									3	1
Bartsia trixago									2	1
Gladiolus communis									3	1
Allium ampeloprasum					2					1
Lium strictum					1					1
Evolvulus arizonicus					+					1
Thapsia garganica					1					1
Opuntia ficus indica						+				2
Eucalyptus gomphocephala									+	1

Table 10 (Tabela 10): *Clematido cirrhosae-Juniperetum lyciae chamaeropetosum humilis* subass. nov.

RELEVÉ NUMBER	R7	R10	R11	R24	R25	R26	R37	R38	R39	R40	R55	R60	R71	R75	R78	
Coordinate Lat. North Long. West	-6.6890 34.2094	-6.6858 34.2170	-6.6882 34.2148	-6.6789 34.2258	-6.6720 34.2357	-6.6752 34.2302	-6.6630 34.2548	-6.6629 34.2530	-6.6636 34.2520	-6.6637 34.2514	-6.6669 34.2556	-6.6712 34.2519	-6.6790 34.2407	-6.6966 34.2093	-6.6945 34.2147	
Station	8	12	9	11	11	11	14	11	11	19	5	4	4	7	1	
Elevation (m)	20	18	42	17	16	16	19	34	24	31	20	25	43	20	57	Pr
Orientation	S	SE	S	WS	S	WS	N	N	N	N	S	N	WS	N	S	
Slope (%)	0	0	19,8	3,7	4,4	2,2	3,9	2,8	25	5,3	4,4	28,2	18,2	0	23	
Soil	iii	iii	iii	ii	ii	ii	ii	Ii	ii	iii	ii	ii	ii	i	i	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association *Clematido cirrhosae-Juniperetum lyciae*																
Juniperus phoenicea	3	3	1	2	1	+	3	1	2	3	2	2	1	2	1	15
Ammi majus	2			1	1	2	1	+	1		2	2	+	+	2	12
Fumaria ouazzanensis					2			1	2	2	3	1				6
Limonium sinuatum					1			1	+	2						5
Asparagus aphyllus			1					1	+	2					1	5
Olea europaea					1	1				2			1			4
Fedia pallescens								1	2							2
Ephedra fragilis													+		+	2
Lycium europeaum	+													+		2
Differential species of the subassociation *chamaeropetosum humilis*																
Retama monosperma	+	4	4	3	3	4	3	4	2	4	2	3	2	3	2	15
Solanum sodomeum	+			+			1		+	1	1			1	+	8
Chamaerops humilis	+			2	+				+			1			+	6
Achyranthes sicula								3	1	2	1				2	5
Marrubium vulgare	1		1				1	1								4
Asparagus albus				3		3			1	1						4
Cerinthe major								2	1						1	3
Other species																
Emex spinosa		3	2	3		2	3		2	2	3			3	2	10
Galactites elegans				3	2		3	3	2	1		1		2	3	9
Anagalis arvensis				2			2	2		3	2	3		2	3	8
Rumex bucephalophorus			3				2	2	2	3	2	3			1	8
Silene gallica	1		2	2	2		2	1	1			2				8
Lagurus ovatus	2		3	2		2		2			2			3	2	8
Plantago lagopus	2			2	2		2		2	3			2			7

RELEVÉ NUMBER	R7	R10	R11	R24	R25	R26	R37	R38	R39	R40	R55	R60	R71	R75	R78	Pr
Lotus corniculatus					1		3		3	3	3	3			3	7
Tolpis barbata		2	3	2	3	1		2				1				7
Hordeum murinum	3		3				2	2		1				3	3	7
Urtica membranacea							2	2		2	2			2	2	6
Paronychia argentea				2	1					1	2	3				5
Arctotheca calendula			2							1			1	2	3	5
Centaurea pullata		1					2		+	2				2		5
Erodium cicutarium				+		1	3		2					3		5
Malva sylvestris	3							3	2					2	1	5
Daucus carota					3		2		2	1						4
Papaver rhoeas								1	+	1	1					4
Ononis spinosa	2										3			3	3	4
Calendula arvensis							3	2		2					2	4
Mercurialis annua					3		2					2		2		4
Arisarum vulgare						2		3				2			2	4
Misopates calycinum								2		+	1	2				4
Verbascum boerhavii							2	+	+	+						4
Sonchus oleraceus					2			3	3	1						4
Parentucellia viscosa					1						+	3				3
Smyrnium olusatrum											2	3			3	3
Vicia sativa		2		2								3				3
Linaria maroccana				+	1	1										3
Astragalus hamosus	1		1						2							3
Lolium perenne								2			3				3	3
Scolymus hispanicus				1			1		1							3
Salvia verbenaca										+	2					2
Echium vulgare					2	2										2
Agropyron junceum				2	2											2
Euphorbia terracina											1	3				2
Torilis nodosa				3	3											2
Verbascum sinuatum	+				+											2
Evax pygmaea							1					2				2
Geranium molle					2			3								2
Cerastium glomeratum	1			+												2
Geranium rotundifolium			3												1	2
Ornithopus sativus				1	2											2

RELEVÉ NUMBER	R7	R10	R11	R24	R25	R26	R37	R38	R39	R40	R55	R60	R71	R75	R78	Pr
Tuberaria guttata		2										3				2
Hypochaeris glabra													2	2		2
Trifolium campestre			2	3												2
Medicago polymorpha											2			3		2
Medicago orbicularis					3			3								2
Briza major (maxima)				3	2											2
Ononis natrix													2		2	2
Hymenocarpos circinnatus				+	1											2
Biscutella laevigata				2	3											2
Plantago macrorbiza				2	1											2
Sonchus tenerrimus					3	2										2
Dipcadi serotinum					2							3				2
Cirsium vulgare					3	2										2
Ricinus communis							3				1					2
Sonchus asper									3		1					2
Pseudorlaya pumila														1	2	2
Urginea maritima										1						1
Avena sterilis					2											1
Nicotiana glauca				1												1
Parietaria mauritanica									3							1
Hypochaeris radicata			1													1
Sherardia arvensis				1												1
Glebionis coronaria										+						1
Trifolium tomentosum		3														1
Moraea sisyrinchium		+														1
Sonchus arvensis	2															1
Linaria purpurea	1															1
Trifolium nigrescens			3													1
Urtica urens			3													1
Medicago minima		1														1
Crepis capillaris			2													1
Delphinium pubescens			+													1
Ornithopus compressus			1													1
Lupinus micranthus						+										1
Erodium ciconium											2					1
Echium plantagineum													1			1

RELEVÉ NUMBER	R7	R10	R11	R24	R25	R26	R37	R38	R39	R40	R55	R60	R71	R75	R78	Pr
Rubia peregrina									1							1
Vicia villosa					1											1
Geranium purpureum											2					1
Poa annua				3												1
Lobularia maritima				3												1
Trifolium cherleri				4												1
Trifolium subterraneum				2												1
Trifolium arvense					2											1
Polypogon monspeliensis					2											1
Misopates orontium					2											1
Schedonorus pratensis					2											1
Hyparrhenia hirta					5											1
Asphodelus microcarpus						3										1
Bascutella laevigata						4										1
Anacyclus clavatus													2			1
Juncus acutus											2					1
Reichardia tingitana							3									1
Lantana camara											2					1
Heliotropium europaeum							2									1
Rorippa sylvestris								2								1
Sedum rupestre									1							1
Sperula rupicola										1						1
Verbascum virgatum											1					1
Galium aparine															2	1
Trifolium hybridum											3					1
Scabiosa atropurpurea											1					1
Melilotus officinalis											2					1
Ficus carica											+					1
Agave americana															2	1
Opuntia ficus indica															2	1
Acacia cyanophylla														+	2	2
Eucalyptus gomphocephala				+												1

Table 11 (Tabela 11): *Solano sodomaeum-Retametum monospermae* (Jdi et al., 1987)

RELEVÉ NUMBER	R4	R5	R28	R9	R12	R3	R77	R1	R31	R36	R73	R88	R2	R33	R56	R6	R13	R14	R15	R16	R17	R30	R108	
Coordinate Lat. North Long. West	-6.6934 34.2062	-6.6916 34.2048	-6.6699 34.2393	-6.6869 34.2130	-6.6891 34.2130	-6.6950 34.2053	-6.6945 34.2120	-6.6958 34.2067	-6.6697 34.2420	-6.6615 34.2565	-6.6913 34.2129	-6.6661 34.2564	-6.6967 34.2058	-6.6732 34.2402	-6.6712 34.2555	-6.6901 34.2075	-6.6913 34.2118	-6.6923 34.2118	-6.6923 34.2111	-6.6923 34.2102	-6.6934 34.2084	-6.6696 34.2412	-6.6803 34.2446	
Station	6	8	11	17	10	6	1	6	11	20	9	5	6	15	7	8	6	6	6	6	6	11	2	
Elevation (m)	20	20	33	40	30	20	30	20	20	25	24	19	20	68	20	20	29	39	22	31	20	27	54	Pr
Orientation	S	S	S	S	N	W	S	N	SE	NE	WS	N	N	N	N	S	N	E	E	W	N	S	N	
Slope (%)	0	0	8	6	9	0	7	0	0	16	12	15	0	7	0	0	15	9	6	4	3	15	51	
Soil	iii	iii	ii	iii	ii	iii	i	iii	ii	ii	iii	ii	iii	Ii	ii	iii	iii	iii	iii	iii	iii	ii	ii	
Relevé size (m²)	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	
Diagnostic species of the association *Solano sodomaeum-Retametum monospermae*																								
Retama monosperma	4	4	5	2	5	3	4	4	4	5	4	2	5	5	5	5	5	4	3	3	5	5	2	23
Chamaerops humilis	+	+	+	+	+	1	+																	7
Solanum sodomeum						+	+	+	+	+	3	2												7
Asparagus aphyllus	2		1						2					1				2						5
Olea europaea			1											1			1					+		4
Ephedra fragilis									+					3									+	3
Arisarum vulgare					1	1																2		3
Clematis cirrhosa											3	2												2
Pistacia lentiscus														1								3		2
Phillyrea angustifolia												+												1
Rubia peregrina									1															1
Other species																								
Rumex bucephalophorus					3	2	1	2			2		1		3	3	4	4		4	2	2		13
Anagalis arvensis	2			2	1		1		1	2	2		1		1	2		1						11
Galactites elegans				1	1		2	2		2	4		+		2	2			2					10
Torilis nodosa	2	1			+			1		3		1				2	2	1	1					10
Arctotheca calendula	4				3	1	2			3	3		1		1	3			2					10
Ammi majus		2	2							2	3	2		5	+		1			1	+			10
Malva sylvestris		3								2	3	3		5	3		3				1			8
Marrubium vulgare					1					+	3		+			1		1	1					7
Paronychia argentea						2	2								2		+		1	2	1			7
Hordeum murinum	3									1	1						1	1	4		3			7
Fumaria ouazzanensis				+					1		3	1					1				+	2		7
Misopates calycinum								1		2			+				2			1	+			6
Lotus corniculatus							2	1		3	3		+		1									6

RELEVÉ NUMBER	R4	R5	R28	R9	R12	R3	R77	R1	R31	R36	R73	R88	R2	R33	R56	R6	R13	R14	R15	R16	R17	R30	R108	Pr
Emex spinosa							2		1	3	4		1		1									6
Evax pygmaea						1	2						+				2			2	+			6
Mercurialis annua					2	+									3	4		3	4					6
Parietaria mauritanica							3			1			2				3				1			5
Hypochaeris glabra		1					3					1			2						+			5
Lagurus ovatus				4			2				3							1	1					5
Scolymus hispanicus								+					+					2					1	4
Verbascum sinuatum	1	+			+								+											4
Nicotiana glauca					+		3				1		+											4
Papaver rhoeas							+			1	4		+											4
Geranium molle										3			1					4	2					4
Centaurea pullata		2		2		1	3																	4
Ononis spinosa				2						2	3									3				4
Delphinium pubescens					+												1				+			4
Limonium sinuatum										+	2									+	+			4
Urtica mem-branacea							3				1	2			3									4
Achyranthes sicula			1						2					2								1		4
Daucus carota			2						3	1													1	4
Juncus acutus							+		1		2			4										4
Plantago lagopus								1		1	1													3
Salvia verbenaca		+					+	1																3
Urtica dioica								2	1												1			3
Vicia lutea													1		2							1		3
Cerastium glomeratum					+								+						1					3
Geranium rotundifolium	1	2				1																		3
Silybum marianum					+	+				+														3
Shenardia arvensis	3					+					2													3
Erodium cicutarium						+				3					2									3
Glebionis coronaria	3		+	1																				3
Lupinus angustifolius		+														3		2		+	1			3
Vicia sativa					2											1		2	1					3
Galactites tomentosus																		3						3
Tolpis barbata			2	1																1				3
Smyrnium olusatrum					2						3						2							3
Melilotus indicus					1															1				3
Sonchus oleraceus									3	3				3										3
Urginea maritima								+					1											2

RELEVÉ NUMBER	R4	R5	R28	R9	R12	R3	R77	R1	R31	R36	R73	R88	R2	R33	R56	R6	R13	R14	R15	R16	R17	R30	R108	Pr
Riechardia tingitana								+		2														2
Plantago coronopus			2										1											2
Ornithopus sativus			3			1																		2
Echium vulgare	1									3														2
Astragalus hamosus										2								2						2
Urtica urens				3														3						2
Scorpiurus muricatus																	+				+			2
Trisetum flavescens															4				4					2
Agropyron junceum														3							3			2
Medicago polymorpha							3														1			2
Cerinthe major									2						+									2
Calendula arvensis										1	4													2
Euphorbia segetalis														3								2		2
Anacyclus clavatus									+		2													2
Lythrum junceum												3		1										2
Trisetaria panicea										1					3									2
Ricinus communis										1	+													2
Trifolium aureum										2					2									2
Galium aparine											2	+												2
Micropyrum tenellum								3																1
Anisantha madritensis								3																1
Avena sterilis													3											1
Hedypnois rhagadioloides						+																		1
Tuberaria guttata						1																		1
Trifolium tomentosum	3																							1
Asparagus albus	2																							1
Eryngium planum		2																						1
Moraea sisyrinchium		+																						1
Silene gallica																		2						1
Linaria purpurea							+																	1
Trifolium nigrescens																		2						1
Centranthus calcitrapae				2																				1
Campanula rapunculus				1																				1
Asphodelus albus				1																				1
Medicago minima									3															1
Umbilicus rupestris					+																			1

RELEVÉ NUMBER	R4	R5	R28	R9	R12	R3	R77	R1	R31	R36	R73	R88	R2	R33	R56	R6	R13	R14	R15	R16	R17	R30	R108	Pr
Lupinus micranthus																	+							1
Astragalus sesamens																	1							1
Trifolium campestre																			2					1
Erodium ciconium																			1					1
Medicago orbicularis											4													1
Campanula lusitanica											3													1
Ononis natrix															1									1
Biscutella laevigata			2																					1
Fedia pallescens											1													1
Prasium majus									2															1
Linaria maroccana											2													1
Trifolium arvense			1																					1
Trifolium angustifolium			3																					1
Lactuca serriola			1																					1
Trifolium repens			2																					1
Lupinus cosentinii									1															1
Juncus maritimus														4										1
Berula erecta														3										1
Lantana camara												2												1
Scille maritime										2														1
Chenopodium album										+														1
Lolium perenne															4									1
Anisantha sterilis											2													1
Verbascum virgatum											2													1
Euphorbia terracina															1									1
Vulpia bromoides															+									1
Scabiosa atropurpurea															1									1

Table 12 (Tabela 12): *Pterido aquilinum-Populetum albae* ass.nov.

RELEVÉ NUMBER	R32	R49	R74	
Coordinate Lat. North Long. West	-6.6720 34.2400	-6.6700 34.2456	-6.6902 34.2139	
Station	15	18	9	
Elevation (m)	69	21	20	Pr
Orientation	N	S	WS	
Slope (%)	11	12	1	
Soil	iv	iv	Iv	
Relevé size (m²)	100	100	100	
Diagnostic species of the association				
Populus alba	+	2	5	3
Pteridium aquilinum	+	+	3	3
Adiantum capillus-veneris	+	+	2	3
Smyrnium olusatrum			3	1
Bryonia dioica			3	1
Smilax aspera			2	1
Espèces compagnes				
Galactites elegans			3	1
Rubus ulmifolius			2	1
Rumex bucephalophorus			3	1
Lotus corniculatus		2		1
Torilis nodosa	1		3	2
Juncus acutus		2	2	2
Rubia peregrina	1	2		2
Solanum sodomeum			1	1
Clematis cirrhosa		2		1
Retama monosperma			+	1
Marrubium vulgare			2	1
Verbascum sinuatum			2	1
Phragmites australis	4			1
Arctotheca calendula			3	1
Nicotiana glauca			2	1

RELEVÉ NUMBER	R32	R49	R74	Pr
Papaver rhoeas		+		1
Anagalis arvensis			4	1
Parietaria mauritanica		3	1	2
Cerastium glomeratum		1		1
Geranium rotundifolium l			2	1
Arisarum vulgare			4	1
Hordeum murinum		3	2	2
Ammi majus			2	1
Malva sylvestris		4	2	2
Lagurus ovatus		2	2	2
Ononis spinosa	2			1
Urtica urens		2		1
Fumaria ouazzanensis		1	4	2
Trifolium campestre			2	1
Agropyron junceum	3			1
Achyranthes sicula		2		1
Cerinthe major		2	3	2
Daucus carota			4	1
Biscutella laevigata		3		1
Fedia pallescens			3	1
Lobularia maritima			3	1
Anacyclus radiatus		2		1
Anacyclus clavatus		1	3	2
Scrophularia auriculata	3			1
Ricinus communis			1	1
Lolium perenne		2	3	2
Anisantha sterilis		3		1
Verbascum virgatum		1		1
Adonis aestivalis		1		1
Galium aparine			2	1
Oxalis pes-caprae			2	1
Brachypodium distachyum			2	1

Legend

Pr: Presence, (i): raw mineral soils on unconsolidated white dunes, (ii): calco-magnesimorphic soils of eolian origin and sandy texture on deep sand and dune sandstone, (iii): Mediterranean red sandy-clay soils, with little moisture on the slopes, superficial on dune sandstone and very deep in the inter-dune depression, (iv): Hygromorphic soils corresponding to the water table, with sandy horizons of varying depths.