Journal of Basic and Environmental Sciences, 9 (2022) 20- 37

ISSN
Online : 2356-6388
Print : 2536-9202

Research paper Open Access

Vegetation analysis of Wadi Kaam at northwest Libya

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Abstract

The present study deals with the vegetation analysis of Wadi Kaam in northwest Libya (130 km east of Tripoli). Sixty stands were selected to represent the variations in 20 locations in 4 major habitats types in this area. The present species were recorded in each stand, and their cover was estimated. In the study area, 152 species belonging to 117 genera and 38 families were recorded. Asteraceae was the most prominent family, represented by 30 species and 18 genera. Two endemic species were recorded (*Herniaria ericifolia* C.C.Towns. and *Poa vaginata* Pamp. Libya). Therophytes were the most represented (47%) of total recorded species, while parasites were the least. Six trees were recorded in the valley (*Pistacia Atlantica* Desf., *Eucalyptus camaldulensis* Dehnh, *Eucalyptus leucoxylon* F.Muell., *Pinus halepensis* Mall., *Pinus canariensis* Sweet ex Sprengel and *Ziziphus lotus* Lam.). Bisexuals were the most designated sex type (141 species = 93% of total recorded species). The maximum frequency of the flowered species was in April (81%), while the minimum was in August (11%). Mediterranean elements were the most represented (35.5 % of the total species), followed by Sahara-Arabian (22.3%). Four vegetation groups were generated after applying TWINSPAN classification technique on the recorded species. Group 1 was dominated by *Peganum harmala* L. and *Ziziphus lotus* Lam, Group 2 *Stipa tenacissima* L, Group 3 *Lobularia Libya* (Viv.) Webb & Berthel. and *Limoniastrum monopetalum (*L.) Boiss. While Group 4 by *Asparagus horridus* L. and *Limoniastrum monopetalous* (L.) Boiss.

Keywords: Endemic species, Vegetation, Flora, Wadi Kaam, Libya

Received; 31 Dec. 2021, Revised form; 11 Jan. 2022, Accepted; 11 Jan. 2022, Available online 23 Jan. 2022.

1. Introduction

Libya is a part of Sahara that is the most extensive area of severe aridity. Its coast has a length of 1700 km, representing the longest coast in the southern Mediterranean region, which extends as a narrow strip with a width varying between 5 and 25 km along the sea and more than 100 km in Jeffara plain in the west [1].

Although most of Libya is in the Sahara Desert, it is crossed by three climate-geographic zones; Mediterranean, semi-desert, and desert zones. The Mediterranean region has dry summers and mild winters, with most precipitation falling in the winter [2]. It has an annual rainfall of 600 mm and has a climate comparable to some parts of southern Europe, but southward this gradually gives way to extreme desert conditions [3]. The semi-desert ecosystem is located in the transitional zone between the mountain and desert zones, with an annual rainfall of 50-150 mm. The Desert ecosystem is the most characteristic and dominant (90% of Libya is desert) [4].

Libyan Flora is not fully understood, particularly in the interior lands, southern mountains, desert valleys, depressions, and northern valleys [5]. However, Libyan Flora was last documented in a series of studies such as; [6], [7], [8], [9], [10]. It has a flora of 1,750 vascular species distributed in 744 genera and 118 plant families [11], [12].

As a part of the north-western of Libya, Wadi Kaam is influenced by the Mediterranean and semi-desert (coastal and mountain ecosystems). Natural vegetation is sparse and generally restricted to drought-resistant plants. Natural vegetation also exists in most Wadis [13]. In Libya, lakes, valleys (Wadis), and springs (Ain) are the sources of the survival of life in coastal areas [14]. Valleys represent a vital habitat in the Libyan Desert; the water presence caused by the flood differs from other adjacent habitats, affecting vegetation density [15]. The present study deals with the vegetation analysis of Wadi Kaam in northwest Libya to assess the plant diversity at species and community levels in different habitats.

2. Study Area

Wadi Kaam is located in the north-western of Libya, between latitude 32° 2'3.21" and 32° 32' 53.41" N, and longitude 13° 49 '52.23" and 14° 26'47. 85" E (Fig. 1). This area covers about 2500 km^2 representing the entire area of the Wadi Kaam [16], including some 28 tributaries, the longest, extends for about 130 km from the upstream in Nafusa mountains (Gabal Nefosa) [17] in the south to the downstream in the Mediterranean, at Kaam village 150 km east of Tripoli [18]. Wadi Kaam is characterized by a large dam with a capacity of 111million m^3 [19] and a freshwater spring with a flow of 350 L sec^{-1} [14].

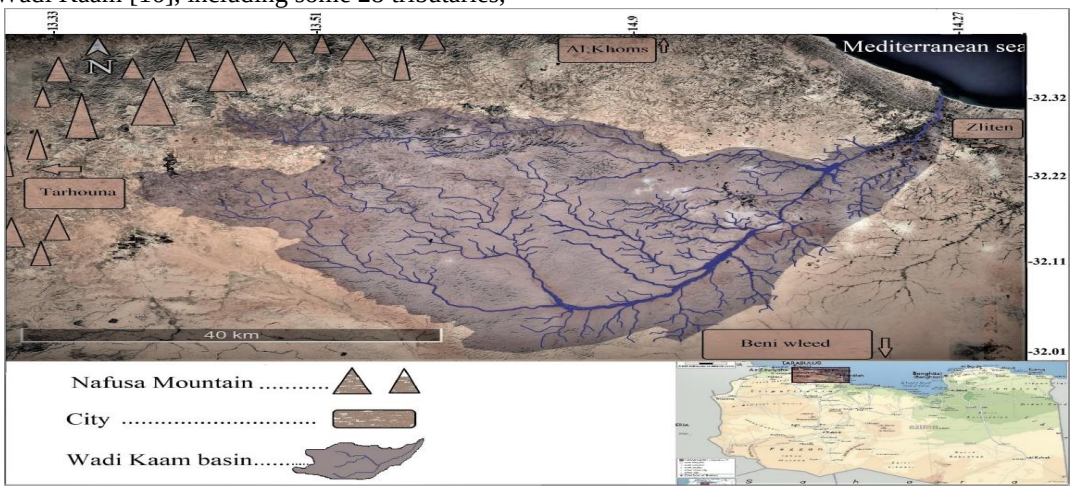


Fig. 1. A satellite map illustrates the area of Wadi Kaam in the north-western of Libya [20].

Two kinds of soil represent mainly the north-western valleys of Libya, including Wadi Kaam [21]. Valleys alluvial soil: deposits cover most of the valley land, which is the result of flood accumulation over a continuous-time, ranging from clay and sandy, with proportions of gravel, stones, dissolved salts, calcium carbonate and gypsum. Sediments of water-courses soil (pluvial) mainly exist in narrow and small tributaries. It is different from alluvial soil because it is formed under extreme flow conditions, rich in stones that are rarely included in layers. It is composed of stone crumbs with a thickness of several meters, it's cohesive and coherent by carbonate or gypsum [16].

Two climate-geographic zones affect the study area; 1- Mediterranean littoral, which is the most heavily populated and most suitable for agriculture, 2- semi-desert area, which is chiefly grazing. The temperature variation is due to hot summers and cold winters. Reverse northwest winds are frequent and responsible for the rainy winters. In summer, hot winds are known locally as "Alghibli" from the southern Sahara Desert [22]. Rainfall in the northern part of Libya varies between 100-500 mm yr^{-1} [4], [23]. Rainfalls between October and March, but occasionally also in April and May. December and January are the wettest months. The rain reaches 350 mm year^{-1} along Jabal Nafusah and the western coast [22].

3. Material and methods

3.1. Field studies:

Sixty stands were randomly sampled in 20 locations distributed in 4 main habitats in the study area (estuary, dam and lake, main-course, and headwaters. The sampling process was carried out during March-June (2019), when most species were expected to be growing. In each stand, species present were recorded. The plant cover was estimated quantitatively using the line intercept method [24]. Life forms of the recorded species were identified following the system of [25]. The flowering times and sex forms of the recorded species were assessed in the field and confirmed with those indicated in [13], [6], [10], [26], [27]. The national and global geographical distributions of the recorded species in the study area were gathered from [6].

3.2. Plant identification:

The plant identification was carried out by the author following these references; [28], [29], [6], [30], [31]. All the collected Herbarium specimens were deposited in Tanta University Herbarium (TANE). The life forms of the recorded species were identified following the well–known system of [25]. The sex forms and flowering times of the recorded species were assessed in the field and confirmed with those indicated in [13], [6], [26], [27]. The recorded species' national and global geographical distributions in the study area were gathered from [6], [27].

3.3. Data analysis: 2

Two-way indicator species analysis (TWINSPAN) and detrended correspondence analysis (DECORANA) were applied to the cover estimates of 152 species in 20 locations [32], [33]. The average number of species per stand was used to calculate species richness (alpha diversity) for each vegetation group (VG). The total number of species in each vegetation group divided by its richness was used to calculate species turnover (beta diversity) [34]. The relative concentration of species dominance using Simpson index (C) and relative species evenness using Shannon-Weiner index (H) was calculated for each vegetation group based on the relative cover (pi) of species [35], [36]. Where H =$\sum_{i=1}^{n} Pi$ log Pi and C = $\sum Pi^2$.

4. Results:

The current study recorded 152 species belonging to 117 genera and 38 families (Appendix 1). The Sympetalic species were the most represented by 65, 44 genera, and 21 families (the most represented was the Asteraceae with 30 species); while Archichlamydeae had 61 species related to 53 genera and 21 families; (the most represented was the Brassicaceae with 13 species) and the Monocotyledonae with 24 species related to 19 genera and 3 families (the most represented was the Poaceae with 21 species). Taxic diversity of the 4 habitats indicated that the habitat of the main course had the maximum number of families and species but the second order in genera, while the habitat of headwaters had the lowest number of families, genera and species (Tables 1, 2).

Table 1. Taxic diversity of the major taxonomic groups of the flora of Wadi Kaam Area. Ac: actual number and Re: relative number (%).

Taxonomic group	Family (F)		Genus (G)		Species (S)		S/G	G/F
	Ac	Re	Ac	Re	Ac	Re		
Gymnospermae	1	2.6	1	1	2	1.2	2	1
- Archichlamydeae	21	55.3	53	45.2	61	40.1	1.2	3
-Sympetalae	13	34.2	44	37.6	65	42.7	1.4	5
Monocotyledoneae	3	7.9	19	16.2	24	15.5	1.2	8
Total	38	100	117	100	152	100	1.30	3

Table 2. Taxic diversity of the four major habitats identified in Wadi Kaam. Ac. actual number, Re: relative number (%). The maximum and minimum relative values are underlined.

Habitat	Family (F)		Genus (G)		Species (S)		G/F	Sp/G
	Ac	Re	Ac	Re	Ac	Re		
Estuary (A)	18	47.3	46	39.31	57	37.5	2.5	1.2
Dam and lake (B)	24	63.2	57	<u>48.7</u>	74	48.7	2.3	<u>0.9</u>
Main course (C)	26	<u>68.4</u>	44	37.6	78	<u>51.3</u>	1.6	<u>1.8</u>
Headwaters (D)	15	<u>39.5</u>	29	<u>24. 8</u>	34	<u>22.4</u>	1.9	1.17

The relation between the number of species, genera and families and the number of habitats in which they occur; indicated an exponential decrease in the number of species, genera and families regarding the number of habitats (Fig. 2).

Seventy-eight (51%) of total species had a distribution restricted to one habitat; 29 of them (19%) had restricted to the habitat of dam & lake (B), (27=18%) to the main course (C), (20=13%) to the estuary (A) and the species of *Alkanna tinctoria* and *Cynara cardunculus*. (1.3%) were restricted to the habitat of headwater (D). While 62 species (41%) occurred in 2 habitats, 8 species (5.2%) in 3 habitats, and 4 species (2.5%); *Peganum harmala*, *Ricinus communis*, *Cynodon dactylon* and *Stipa tenacissima* had a wide distribution to all study area's habitats (A, B, C and D) (Fig. 3).

In the present study, six perennial trees were recorded (*Pistacia atlantica, Eucalyptus camaldulensis*, *Eucalyptus leucoxylon*, *Pinus canariensis*, *Pinus halepensis* and *Ziziphus lotus*. *Pistacia atlantica*, found mainly in the habitat of headwaters and few in the habitat of the main course. *Eucalyptus camaldulensis* and *Eucalyptus leucoxylon* are widely distributed in the habitat of dam & lake and main course, *Pinus canariensis* and *Pinus halepensis* are dominant in habitat estuary, dam & lake and few in the main course. While *Ziziphus lotus* is dominant in habitats headwaters and main course, but few in dam & lake (Appendix 1).

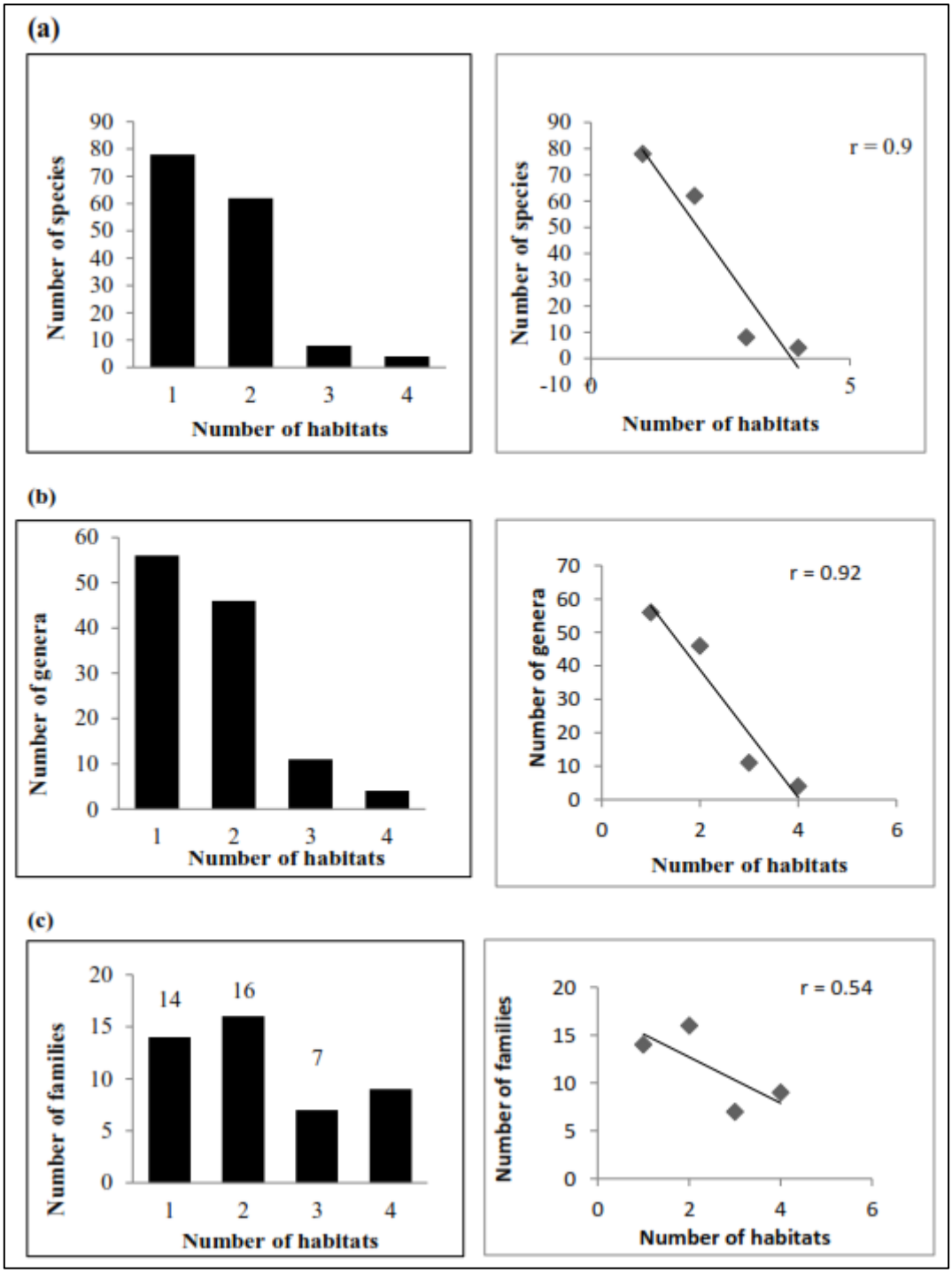


Fig. 2. Relation and regression line between the number of species (a), genera (b) and families (c) and the number of habitats in which they occur (r = the correlation coefficient).

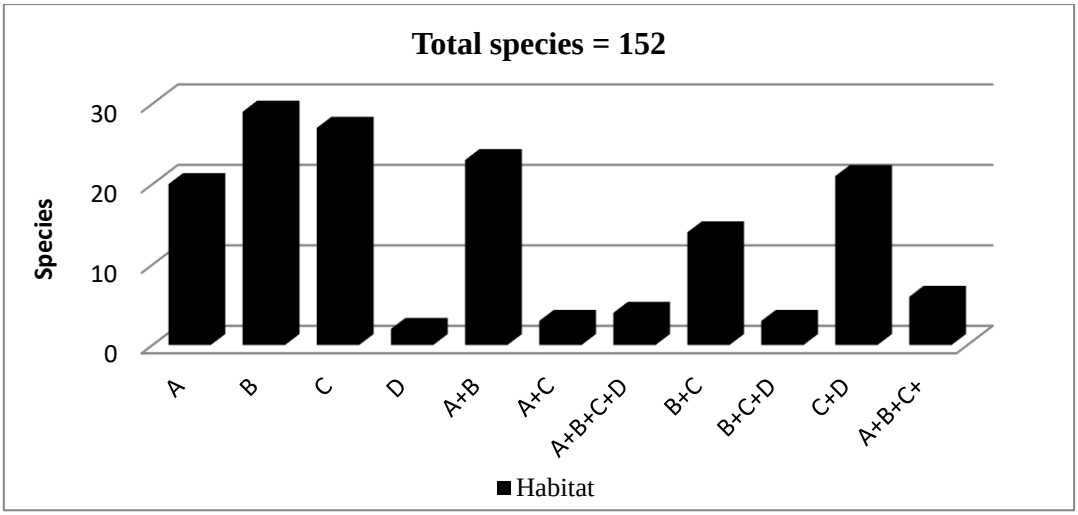


Fig. 3. The number of species in Wadi Kaam in relation to the habitat in which they occur. (A): estuary, (B): dam & lake, (C): main course and (D): headwaters.

Therophytes are the most represented life forms (72 species = 47% of total species) followed by chamaephytes (31 species = 20%) and hemicryptophyte (20 species = 13%), while parasites are the least represented (one species = 0.6%) (Fig. 4). The sex of the recorded species are expressed in the following forms: bisexual (i.e. hermaphrodites), unisexual (either monoecious or dioecious) and monoecious. They are arranged ascendingly as follows: Dioecious (2 species = 1.3%), monoecious (9 species = 5.7 %) and bisexual (141 species = 93 %).

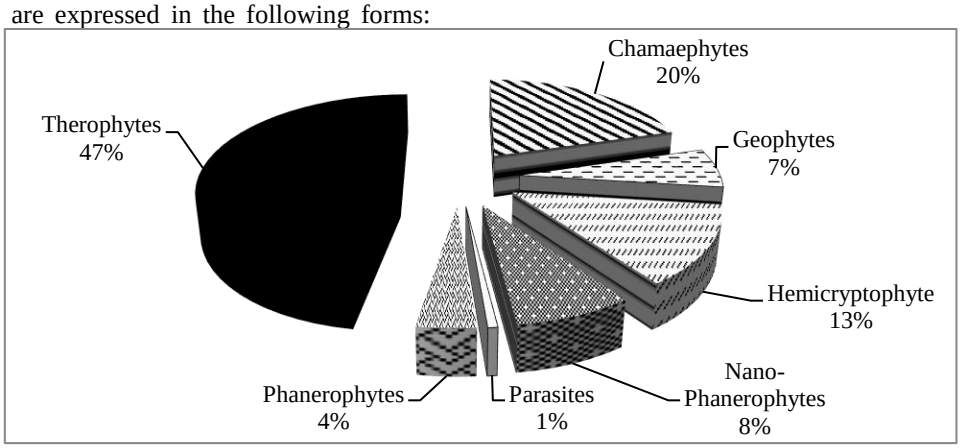


Fig. 4. Life form spectrum of the recorded species in Wadi Kaam at North-Western Libya.

The frequency of the flowered species increases rapidly from January (37 = 24% of total species) to a maximum in April (124 = 81%), then decreases to a minimum in August (17=11%), but gradually increases from October (19 = 12%) to December (23 = 15%). In general, the months of March to May have the highest flowering activity, while August to October has the lowest (Fig. 5).

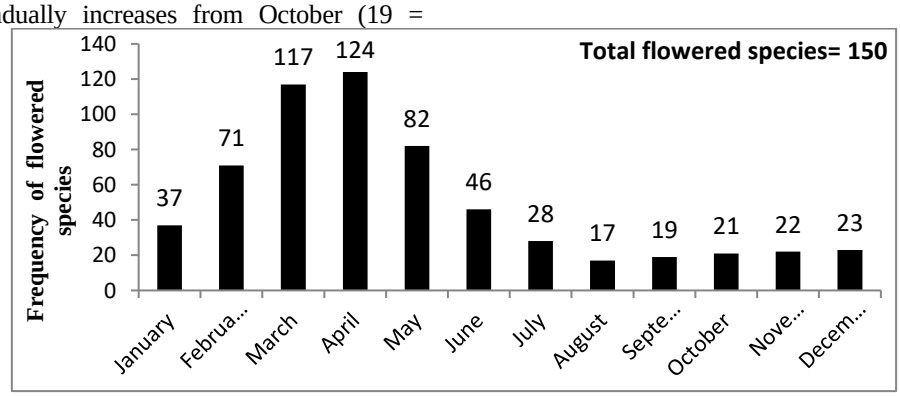


Fig. 5. Frequency of the recorded species in Wadi Kaam with their flowering time.

Regarding the variation in flowering time in relation to life forms, the maximum flowering of most life forms was in April, followed by March and May, While the minimum flowering time was in August except that of the Geophytes which in December (Fig. 6)

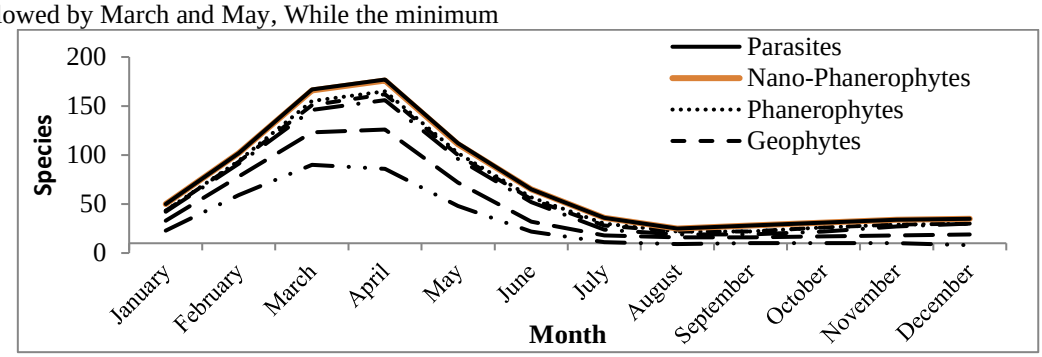


Fig. 6. The number of flowered species in Wadi Kaam in relation to their life forms.

Fifty-nine species (38%) were recorded for the first time in the present study (Appendix 1). Eleven species (*Pinus canariensis*, *Herniaria ericifolia*, *Brassica tournefortii*, *Diplotaxis muralis*, *Ruta chalepensis*, *Anethum graveolens*, *Deschampsia cespitosa*, *Pennisetum setaceum* and *Stipa tenacissima*) had a distribution restricted to the study area and other surrounding areas (the coastal regions). At the same time, *Anethum graveolens*, *Cleome amblyocarpa*. and *Ruta chalepensis* mainly belonged to Jabal Nafosa, while *Calepina irregularis*, *Bunium fontanesii*, *Artemisia judaica* and *Ajuga chamaepitys* mainly belonged to Aljabal Al-Akhdar and Sahara regions. On the other hand, 71 species had a wide geographical distribution all–over Libyan phytogeographical regions (Fig. 7).

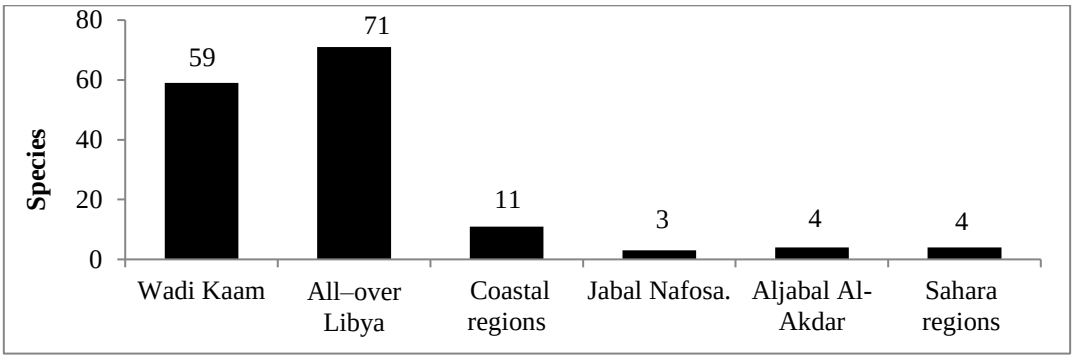


Fig. 7. The number of species recorded in Wadi Kaam in relation to the number of phytogeographical regions in which they occur.

Two endemic species were recorded in the study area (*Herniaria ericifolia* and *Poa vaginata*). Mediterranean elements were the most represented (54 species = 35.5 % of total recorded species), followed by Saharo-Arabian (34 = 22.3%), then Sub cosmopolitan (25=16.4%), while Saharo-Sindian (8=5.2%), Euro-Siberian (7= 4.5%) and Palaeotopical (2 =1.3%) were the less represented regions (Fig. 8)

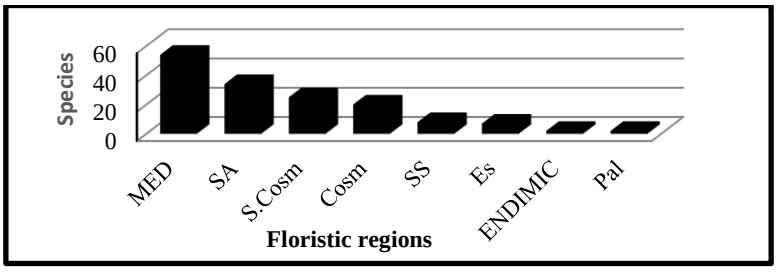


Fig. 8. Descending distribution of the Recorded species in Wadi Kaam in relation to their floristic regions. MED = Mediterranean, SA = Saharo-Arabian, S.Cosm = Sub-cosmopolitan, COSM = Cosmopolitan, SS = Saharo-Sindian, ES = Euro-Siberian, and Pal = Palaeotopical.

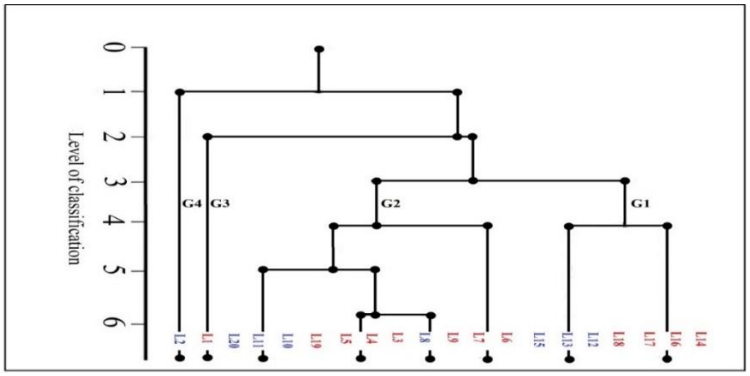
After the application of the TWINSPAN, the 152 species in the 20 locations were classified into 4 groups (G1- G4) at the third level. These groups are well segregated along axes 1 and 2 of the DECORANA ordination (**Fig 9 a and b**). G1 comprises seven locations that inhabit the main course and headwaters and is characterized by Peganum harmala and Ziziphus lotus dominance. G2 contains eleven locations inhabit the estuary, dam & lake, main course and the headwaters, and is characterized by *Stipa tenacissima.* and *Hordeum marinum* G3 comprises only one location inhabit the estuary and is characterized by *Lobularia libyca* and *Limoniastrum monopetalum*. G4 also contains only one

other location that belongs to the estuary and is characterized by *Asparagus horridus* and *Limoniastrum monopetalum*. G2 was the most diverse; it had the highest species richness (70.8 species stand^{-1}), and species turnover (1.6), while G3 was the least diverse with the lowest species richness value (4 species stand^{-1}), and 1.0 species turnover (Table 3).

Table 3. Characteristics of the 4 vegetation groups resulted after applying TWINSPAN classification on the 20 sampled locations in Wadi Kaam. RCD: Relative concentration of species dominance and RSE: Relative evenness of species dominance, P(%): presence percentage

Species characters	Vegetation group			
	Group-1	Group-2	Group-3	Group-4
Total species	76	114	4	6
Total stands	7	11	1	1
Species richness	22.57	70.82	4.00	6.00
Species turn over	3.37	1.61	1.00	1.00
RCD	1.6	1.7	0.34	0.20
RSE	0.044	0.028	0.6	0.60
Dominant species P (%)	*-Peganum harmala* (100%)	*- Stipa tenacissima* (63%)	*-Lobularia libyca* (100%)	*-Asparagus horridus* (100%)
	-Ziziphus lotus (85%)	*-Hordeum marinum* (45%)	*-Limoniastrum monopetalum* (100%)	*-Limoniastrum monopetalum* (100%)

(a) Classification



(b) Ordination

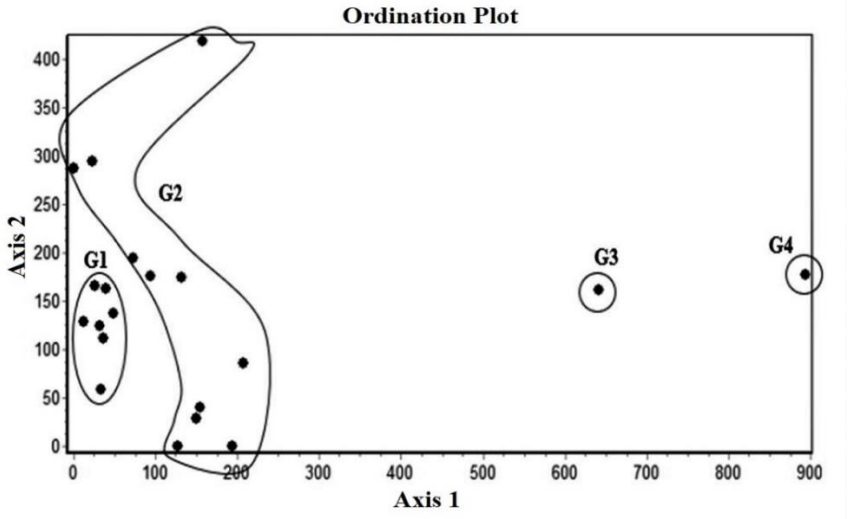


Fig. 9. Classification (a) and ordination (b) of the 20 locations (L1 - L20) of Wadi Kaam by application of TWINSPAN and DECORANA.

5. Discussion

In the present study, 152 species belonging to 117 genera and 38 families were recorded from 60 stands distributed in the estuary, mainstream, tributaries and headstreams of Wadi Kaam, north-western Libya. In comparison, 102 species related to this area were recorded by [6], 342 species by [35], 58 species by [38] and 158 by [39]. The variation in the number of recorded species could be due to the differences in the boundaries of the studied areas.

Habitat's main course was the most diverse; it had the highest number of species and, highest species richness, that perhaps because it is the meeting place of most of the valley's tributaries, which is rich in water and silt accumulated from the tributaries [21]. Also, it may be due to the remoteness from the population centers, which reduces the risks upon the vegetation cover [40].

Although most recorded species are restricted to some habitats and locations, some species such as *Cynodon dactylon* and *Carduus getulus*, *Silybum marianum* and *Onopordum arenarium* are common and randomly distributed in almost entire areas of the valley, perhaps due to grazing where some of their parts and seeds of these species are attached to the livestock lists and spread widely [40]. In addition, 59 species (38%) were recorded for the first time in the study area had not been recorded in this area by [6]. This finding may be because this study extends into areas far from cities and paved roads more than the study of Flora of Libya [6]. However, these species were recorded in the Libyan Flora near the study area [40].

Six perennial trees belonging to 4 genera and 4 families were recorded in the study area as a part of its natural flora *Pistacia atlantica*, *Eucalyptus camaldulensis*, *Eucalyptus leucoxylon*, *Pinus canariensis*, *Pinus halepensis* and *Ziziphus lotus*. Three of them; *Eucalyptus camaldulensis*, *Eucalyptus leucoxylon*. and *Pinus canariensis* was not recorded in Flora of Libya [6], but these in other studies; *Eucalyptus camaldulensis, Eucalyptus leucoxylon* by [41] and *Pinus canariensis* by [39]. All of them were recorded in Messallata,"one of the headwaters of Wadi Kaam". Avoiding recording them in some previous studies may probably be considered exotic species [40].

However, they grow naturally in the region for tens of years. However, this study indicates that the presence of the perennial tree varies according to the habitat; species of *Eucalyptus camaldulensis*, *Eucalyptus leucoxylon*, *Pinus canariensis* and *Pinus halepensis* were abundant north of the valley (estuary and dam). While *Pistacia atlantica*, was restricted to the main course and headwaters in the south. These trees are abundant because they are characterized by drought resistance [17]. On the other hand, *Ziziphus lotus* was recorded in the all valley habitat, but rarely in the north and abundant in the south [40].

Determination of life forms of the recorded species indicated that therophytes represent the most considerable portion of the species (47% of total species), followed by Chamaephytes (20%) and Hemicryptophyte (13%). This result almost agreed with the study of [42]. The dominance of the therophytes in the study area makes the spring season the main flowering period. [25] designated the Mediterranean climate as a "therophyte climate type" because of the high percentage of this life form (>50% of the total species) in several Mediterranean floras [43]. The short life cycles of the field crops and their weed association (the new land use at present are rain-fed farming [44], in addition to the adverse climatic conditions, moisture deficiency and substrate instability, probably lead to the frequent occurrence of therophytes during the favorable seasons [42].

The preponderance of the hermaphroditic species (i.e. bisexual species) is a common character in floras worldwide [45]. However, the trees and other woody species have the highest incidence of dioecy, while the herbs have the lowest. Some studies in the Tropics have revealed that the dioecy is associated with fleshy fruits and animal dispersal seeds. Moreover, most dioecious species are animal pollinated [46].

About 60 species (40%) flowered next to the rainy season (March, April and May). On the other hand, 5 species had a flowering period of almost the year, 3 species all the year, 1 species most of year and 2 species twice a year, one of them in March-April and May-June and the other in March-April and July-October. In contrast, the other 81 species had various flowering periods during the year. This result was reported in [6], [27].

The Mediterranean elements were the most represented in Wadi Kaam, followed by Saharo-Arabian. This is due to the geographical elements of Libyan flora being dominated by the Mediterranean and the Sahara Desert. The floristic elements and distribution characteristics also indicate that the plants' climate and environmental conditions, ecological amplitude, and adaptive capacity are associated with the floristic origin and spatial patterns of plant diversity [4].

Acknowledgments

The Deepest thanks are extended to the Ministry of Higher Education and Scientific Research in Libya and The Cultural Attaché at the Libyan Embassy in Cairo.

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Appendix 1. Recorded species in 20 locations in the four habitats of Wadi Kaam; [**first recorded, Life-form (Th=Therophytes, Ch=Chamaephytes, H= hemicryptophytes, He=Helophyte, Cl=Climber, G=Geophytes, Pa =Parasites, N-Ph=Nano-Phanerophytes, Ph=Phanerophytes, Li=Lianes, Su=Succulent) **Global distribution** (**MED**=Mediterranean, **ES**=Eru-Siberian, **SA**=Saharo-Arabian, **IT**=Irano-Turanian, **SZ**=Sudano-Zambezian and Saharo-Zambezian, **SS**=Saharo-Sindian, **Pal**=Palaeotopical, **S.Afr**,=South Africa, **COSM**=Cosmopolitan, **S.Cosm**=Sub cosmopolitan). T. Ind.= Total number of individuals of each species and Pi= the proportion of individuals of each species].

No	Species	Life form	Global distribution	Locations																				T. Ind.	Pi
				Estuary					Dam & lake					Main course					Headwaters							
				1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20		
1	*Adonis aestivalis* L.	TH	MED+ES								1	1												2	0.1 %
2	*Adonis dentata* Delile	G	MED									4				2								6	0.4 %
3	*Adonis microcarpa* DC	G	MED									1												1	0.1 %
4	*Aetheorhiza bulbosa* (L.) Cass. **	TH	MED+SA									1	1											2	0.1 %
5	*Ajuga chamaepitys* (L.) Schreb. **	CH	SA									2												2	0.1 %
6	*Ajuga iva (*L.) Schreb**	TH	SA						2			2												4	0.3 %
7	*Alkanna tinctoria* (L.) Tausch	CH	SA																	2				2	0.1 %
8	*Amaranthus viridis* L **	Th	Cosm			1																		1	0.1 %
9	*Ammi visnaga* (L.)Lam. **	TH	SA+IT					2														2	3	7	0.5 %
10	*Anacyclus clavatus* (Desf.) Pers. **	TH	MED+IT													1	1	1	1					4	0.3 %
11	*Anacyclus monanthos* (L.) Thell.	TH	MED+IT									1												1	0.1 %
12	*Anagallis arvensis* L.	TH	SA									9				5								14	1.0 %
13	*Anethum graveolens* L.	TH	SA+IT									1												1	0.1 %
14	*Anthyllis vulneraria* L.	TH	ES+MED+IT									1				1								2	0.1 %
15	*Artemisia herba-alba* Asso.	H	MED+SA												3								2	5	0.4 %
16	*Artemisia judaica* L.**	H	MED+SA														3			1			1	5	0.4

																								%
17	*Asparagus horridus* L.	H	S-Cosm		1																		1	0.1 %
18	*Astragalus stella* L.	Ch	MED													3	3						6	0.4 %
19	*Atractylis cancellata* L**	TH	MED+IT													1						1	2	0.1 %
20	*Atractylis carduus (*Forssk.) C.Chr.	TH	MED+IT						1	2								1			1		5	0.4 %
21	*Atractylis delicatula* Batt. ex L.Chevall.	TH	MED+IT										6					3				6	15	1.1 %
22	*Atractylis serratuloides* (Cass.) DC.	TH	MED+IT					4								1	1						6	0.4 %
23	*Avena barbata Pott ex* Link	G	S-Cosm			6																	6	0.4 %
24	*Brachypodium distachyon* (L.) P.Beauv.	TH	S-Cosm				10																10	0.7 %
25	*Brassica tournefortii* Gouan**	H	MED													5	7					1	13	0.9 %
26	*Bromus diandrus* Roth.**	TH	S-Cosm				5				10			3								10	28	2.0 %
27	*Bromus madritensis* L.**	CH	S-Cosm				10						9	2									21	1.5 %
28	*Bunium fontanesii* (Pers.) Mair**	CH	SA+S.Afr					1															1	0.1 %
29	*Cakile maritima* Scop.**	CH	MED						3														3	0.2 %
30	*Calepina irregularis* (Asso) Thell.**	TH	MED											3	6								9	0.6 %
31	Calicotome villosa (Poir.) Link.	Th	MED						1														1	0.1 %
32	*Calotropis procera* (Aiton) Dryand.	N.Ph	Cosm			1										1			1	1		1	5	0.4 %
33	*Carduus getulus* Pomel.	H	MED+SA													3	2		4	3			12	0.9 %
34	*Carthamus eriocephalus* (Boiss.) Greuter.	TH	MED+SA							2						2	1		1		7	1	14	1.0 %
35	*Carthamus lanatus* L.**	CH	MED+SA						2	3	3					1	1	2		7			19	1.3 %
36	*Cenchrus ciliaris* L.**	TH	S-Cosm				12			1		2					2		5				22	1.6

																								%
37	*Centaurea furfuracea* Coss. & Durieu**	TH	MED+IT			1			1														2	0.1 %
38	*Centaurea glomerata* Vahl.	TH	MED+IT													1					1		2	0.1 %
39	*Centaurea maroccana* Ball.**	H	MED+IT					3					2		3				6			3	17	1.2 %
40	*Centaurea pumilio* L**	TH	MED+IT												3	2							5	0.4 %
41	*Chenopodium murale* L.	Th	Cosm			3																	3	0.2 %
42	*Citrullus colocynthis (*L.) Schrad.**	Ch	ES+MED											1									1	0.1 %
43	*Cleome amblyocarpa* Barratte & Murb.**	TH	Cosm											10									10	0.7 %
44	*Convolvulus arvensis* L.	CH	SA												1								1	0.1 %
45	*Cynara cardunculus* L.	H	MED+SA							8			7										15	1.1 %
46	*Cynodon dactylon* (L.) Pers.	N.Ph	S-Cosm			10			20	15		5			23	9	10	20	23				135	9.6 %
47	*Delphinium halteratum* Sm.	TH	MED+ES												1								1	0.1 %
48	*Deschampsia cespitosa* (L.) *P.Beauv.***	TH	S-Cosm			1																	1	0.1 %
49	*Deverra denudata* (Viv.) **	Th	SA+SZ					1															1	0.1 %
50	*Diplotaxis harra* (Forssk.) Boiss.	H	MED						2			2											4	0.3 %
51	*Diplotaxis muralis* (L.) DC. .	N.Ph	MED									2											2	0.1 %
52	*Diplotaxis simplex* Spreng.	CH	MED						1			11											12	0.9 %
53	*Drimia maritima (*L.) Stearn.	N.Ph	S-Cosm									1		2		2							7	0.5 %
54	*Echinops galalensis* Schweinf.	TH	MED+IT												1								1	0.1 %
55	*Echinops spinosissimus* Turra.	N.Ph	MED+SA				4							2		3	1			5			15	1.1 %
56	*Echium angustifolium* Mill.	TH	SA			1																	1	0.1

																								%
57	*Echium sabulicola* Pomel**	TH	SA										2				2			3				7	0.5 %
58	*Emex spinosa* (L.) Campd.	G	MED									3				7								10	0.7 %
59	*Eremobium longisiliquum* (Coss.) Boiss.**	TH	MED						11															11	0.8 %
60	*Erigeron bonariensis* L.	CH	MED+SA+IT			2																		2	0.1 %
61	*Erodium laciniatum* (Cav.) Willd	TH	MED+IT			1				4						4								9	0.6 %
62	*Erucaria pinnata* (Viv.) Täckh. & Boulos.	CH	MED													1	1		1					3	0.2 %
63	*Eucalyptus camaldulensis* Dehnh**	Ch	S-Cosm											1										1	0.1 %
64	*Eucalyptus leucoxylon* F.Muell..**	TH	S-Cosm									1				2	1							4	0.3 %
65	*Euphorbia terracina* L.**	TH	ES+MED			3																		3	0.2 %
66	*Fagonia scabra* Forssk.	TH	MED+ES+SA							2		3												5	0.4 %
67	*Ferula tingitana* L.**	H	SA+SZ					3																3	0.2 %
68	*Fumana thymifolia* (L.) Spach	TH	Cosm												2									2	0.1 %
69	*Fumaria parviflora* Lam.**	H	Cosm													2	2							4	0.3 %
70	*Glebionis coronaria* (L.) Cass. ex Spach.	N.Ph	Pal									1												1	0.1 %
71	*Gymnocarpos decander* Forssk	G	Cosm					1					1	1								1		4	0.3 %
72	*Haloxylon scoparium* Pomel.	Th	Cosm					1			1			1										3	0.2 %
73	*Helianthemum lippii* (L.) Dum.Cours.	TH	Cosm													3								3	0.2 %
74	*Herniaria ericifolia* C.C.Towns.**	TH	Cosm							1		9												10	0.7 %
75	*Herniaria hirsuta* L.**	G	Cosm						1			1												2	0.1 %
76	*Hippocrepis areolata* Desv.	N.Ph	MED								3	4												7	0.5

																								%
77	*Hordeum marinum* Huds.	TH	S-Cosm				8		2	3	4				5						5		1	28	2.0 %
78	*Juncus acutus* L.**	TH	S-Cosm			3																		3	0.2 %
79	*Kickxia acerbiana* (Boiss.) **	CH	SA									4				2								6	0.4 %
80	*Launaea nudicaulis* (L.) Hook.f	PA	Pal												3	4	11		10	5				33	2.3 %
81	*Lavandula multifida* L	TH	SA						9															9	0.6 %
82	*Limoniastrum monopetalum* (L.) Boiss.**	CH	SA	1	1																			2	0.1 %
83	*Limonium pruinosum* Kuntze**	H	SA					5						1		1								7	0.5 %
84	*Lobularia libyca* (Viv.) Webb & Berthel.**	CH	MED	13																				13	0.9 %
85	*Lolium rigidum* Gaudin.	H	S-Cosm							2		2	5			1			5					15	1.1 %
86	*Lotus cytisoides* L.	CH	MED									1					1							2	0.1 %
87	*Lotus halophilus* Boiss. & Spruner	CH	MED								2													2	0.1 %
88	*Lycium europaeum* L.**	CH	SA															2	1				1	4	0.3 %
89	*Lygeum spartum* Loefl. ex L.	TH	S-Cosm			2	3	2																7	0.5 %
90	*Malva parviflora* L.	PH	Cosm									2							5					7	0.5 %
91	*Malva sylvestris* L.	PH	Cosm			5			8		6	4			6	9	3	4		6				51	3.6 %
92	*Marrubium vulgare* L.	TH	SA						2			2												4	0.3 %
93	*Matthiola longipetala* (Vent.) DC.	CH	MED													1	6							7	0.5 %
94	*Matthiola tricuspidata* (L.) R.Br.	N.Ph	MED									1												1	0.1 %
95	*Medicago laciniata* (L.) Mill.	TH	MED												1	2								3	0.2 %
96	*Melilotus sulcatus* Desf	TH	MED			1																		1	0.1

																								%
97	*Neurada procumbens* L.**	G	Cosm													3	3						6	0.4 %
98	*Nicotiana glauca* Graham.	Ch	SA+IT						1	2		1											4	0.3 %
99	*Nitraria retusa* (Forssk.) Asch**	TH	Cosm	1																			1	0.1 %
100	*Olea europaea* L.**	H	SA+SZ++IT					3															3	0.2 %
101	*Onopordum arenarium* (Desf.) Pome	H	S.Cosm									1				3	3			2			9	0.6 %
102	*Onopordum platylepis* (Coss. ex Murb.)**	Ph	S.Cosm						4	1		2					1	1	5		3		17	1.2 %
103	*Orobanche cernua* Loefl.**	CH	SA						2	4													6	0.4 %
104	*Papaver rhoeas* L.	H	Cosm													18							18	1.3 %
105	*Paronychia arabica* (L.) DC.	H	Endemic						10			5											15	1.1 %
106	*Peganum harmala* L	PH	Cosm			3			7	2	1				1	1	6	4	3	1	4		33	2.3 %
107	*Pennisetum divisum* (Forssk. exJ.F.Gmel.)	TH	S-Cosm				6			15				3									24	1.7 %
108	*Pennisetum setaceum* (Forssk.) Chiov**	H	S-Cosm			2	15															3	20	1.4 %
109	*Phragmites australis* (Cav.)Trin.**	TH	S-Cosm		31																		31	2.2 %
110	*Pinus canariensis* Sweet ex sprengel**	TH	Cosm						1			1											2	0.1 %
111	*Pinus halepensis* Mill	Ph	S.Cosm				2									1							3	0.2 %
112	*Pistacia atlantica* Desf.	Th	Cosm															1	1	1	1	1	5	0.4 %
113	*Plantago albicans* L.**	TH	SA									5											5	0.4 %
114	*Plantago lagopus* L**	TH	SA									3											3	0.2 %
115	*Plantago lanceolata* L.	N.Ph	SA									3											3	0.2 %
116	*Poa vaginata Pamp.* libya	Th	SS			4																	4	0.3

																								%
117	*Polypogon monspeliensis* (L.) Desf.	N.Ph	SS		1					5				8	11								25	1.8 %
118	*Pseuderucaria teretifolia* (Desf.)	G	MED														1	1					2	0.1 %
119	*Pteranthus dichotomus* Forssk	G	Endemic						2		1					1							4	0.3 %
120	*Retama raetam* (Forssk.) Webb	TH	MED										3	1		1				3			8	0.6 %
121	*Ricinus communis* L.	CH	ES+MED												1	1							2	0.1 %
122	*Rosmarinus officinalis* L.**	CH	SA									1											1	0.1 %
123	*Rostraria cristata* (L.) Tzvelev**	TH	SS				5								2	3				3		3	16	1.1 %
124	*Rumex conglomeratus* Murray**	TH	MED						30			33											63	4.5 %
125	*Ruta chalepensis* L.	TH	MED+ES						2	1													3	0.2 %
126	*Salvia aegyptiaca* L	TH	SA												2								2	0.1 %
127	*Salvia lanigera* Poir	TH	SA						1			2			3	1							7	0.5 %
128	*Salvia verbenaca* L	H	SA												2								2	0.1 %
129	*Scabiosa arenaria* Forssk.	Ch	SA								1	2											3	0.2 %
130	*Scabiosa eremophila* Boiss.	TH	SA						5	1													6	0.4 %
131	*Scabiosa monspeliensis* Jacq.	TH	SA														1						1	0.1 %
132	*Scorzonera undulata* Vahl	N.PH	S.Cosm													1					1		4	0.3 %
133	*Searsia tripartita* (Ucria) Moffett.	Ch	Cosm						1					1									2	0.1 %
134	*Silybum marianum* (L.) Gaertn.**	TH	S.Cosm						1			3			4	3	1		1				13	0.9 %
135	*Sisymbrium irio* L**	CH	MED									3											3	0.2 %
136	*Solanum americanum* Mill.**	TH	SA+IT						1			3											4	0.3

																								%
137	*Sonchus oleraceus* (L.) L.	CH	S.Cosm		2																		2	0.1 %
138	*Sonchus tenerrimus* L.	TH	S.Cosm		3																		3	0.2 %
139	*Spergula fallax* (Lowe) E.H.L.Krause.	CH	ES+MED			2																	2	0.1 %
140	*Stipa barbata* Desf	H	SS											16									16	1.1 %
141	*Stipa capensis* Thunb.	TH	SS+SZ					11	20					34									65	4.6 %
142	*Stipa parviflora* Desf.	N.PH	Z+SA+MED				30																30	2.1 %
143	*Stipa tenacissima* L.	H	SS+Sz+IT	2		2		1		4	3		5	4							5	4	30	2.1 %
144	*Stipagrostis plumosa* Munro exT.Anderson	CH	SS				13																13	0.9 %
145	*Thesium humile* Vahl.	TH	MED+ES+IT																	12			12	0.9 %
146	*Thymbra capitata* (L.) Cav.	TH	SA												10								10	0.7 %
147	*Trigonella anguina* Delile**	TH	MED													3							3	0.2 %
148	*Tripodion tetraphyllum* (L.) Fourr.	Th	ES+MED+IT											2		4							6	0.4 %
149	*Vicia monantha* Retz	TH	MED													9	3	1	8	5			26	1.8 %
150	*Volutaria crupinoides* (Desf.) Cass. **	TH	S.Cosm											2		1							3	0.2 %
151	*Xanthium spinosum* L.	Ch	SA												1			1					2	0.1 %
152	*Ziziphus lotus* (L.) Lam.	Ph	MED+IT										1	1	1	1	1	1	1	1		1	9	0.6 %
																							1408	100%