



Floristic Features of Lake Manzala in Mediterranean Coast of Egypt

Nada H Kabo¹, El-Sayed F. El-Halawany¹, Ghada A. Khder², Yasser A. El-Amier^{1*}

¹ Botany Department, Faculty of Science, Mansoura University, Mansoura - 35516, Egypt

² Agriculture Applications Department, National Authority for Remote Sensing and Space Science

* Correspondence to: yasran@mans.edu.eg; Tel. +201017229120

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Abstract A list of plant species, life spans, life-form spectra, and a floristic analysis of the plant life along the shoreline of lake Manzala wetland. Floristically, there are 63 species of flowering plants that have been identified in the current study. These species are divided into 50 genera and 30 families. The primary groups are Chenopodiaceae, Asteraceae, Poaceae, and Cyperaceae, which together account for 28 species, or around 44.4% of the total number of documented species. The majority of plants are cryptophytes, which include helophytes, geophytes, and hydrophytes (32%) and partly nanophanerophytes (4 percent). These species were divided into four groups based on their ecological characteristics: four floating hydrophytes, four submerged hydrophytes, fourteen emergent species, and 41 terrestrial species.. According to the floristic analysis of the study area, 35 species, or around 55.55 percent of the total number of species recorded, are accounted for by taxa from the Mediterranean. Biregional (16 species = 25.39%), monoregional (6 species = 9.52%), or pluriregional (18 species) taxa are all represented..

keywords: Manzala, Lake; wetland; Floristic, Hydrophytes, Flora.

1. Introduction

Wetlands provide many important services to the environment and to the public. They offer critical habitat for fish, waterfowl and other wildlife, they purify polluted waters, and they help check the destructive power of floods and storms (Natarajan et al., 2018; Dorney et al., 2018; Butt et al., 2021). In addition, wetlands are highly productive and biologically diverse of all ecosystems, serving as home to at least one third of all threatened and endangered species (Suchara, 2019; Balwan and Kour, 2021). There are many different types of wetlands, each determined by its hydrology, water chemistry, soils, and the plant species found there (Boutin, 1993; Butt et al., 2021). They may be fed by precipitation, runoff, or groundwater, with water chemistry ranging from very acidic to alkaline (Mitsch and Gosselink, 2000)

In Egypt, Lake Manzala was a major source of affordable fish for eating, but pollution and lake drainage have decreased the lake's productivity. In 1985, the lakes fishery was an

open area of 89,000 ha and employed roughly 17,000 workers. The government of Egypt drained substantial portions of the lake in an effort to convert its rich Nile deposits to farmland. The project was unprofitable: crops did not grow well in the salty soil and the value of resulting produce was less than the market value of the fish that the reclaimed land had formerly yielded. By 2001, Lake Manzala had lost approximately 80 percent of its former area through the effects of drainage efforts (Wahaab and Badawy, 2004; Abdel-Gaber et al., 2015; Haroon, 2022).

In recent years, the northern part of the Nile Delta has been subjected to extensive anthropogenic activities bring almost contamination and subsequent pollution to our varied ecosystems (Don-Pedro, 1990). One of the biggest issues that people worldwide, especially in developing nations, confront is pollution. However, because it is a product of humans and their activities, it harms the environment and the resources available to

humans (Mendil and Uluözlu, 2007). Numerous human activities result in the release of different contaminants into aquatic ecosystems, endangering the health of living things and degrading the environment by making water bodies unfit (Abowel and Sikoki, 2005; Ekubo and Abowel, 2011).

The primary goal of this effort is to investigate the floristic characteristics of wild plants in Egypt's Manzala Lake, including records of plant species, life spans, life-form spectra, and floristic classifications.

2. Materials and Methods

2.1. Study area

With an area of over 1200 km², Manzala Lake is the largest and most eastern lake in the Nile Delta (31° 02' - 31° 33' N to 33° 47' - 32° 18' E). The Lake is positioned diagonally between the northwest and southeast. The Mediterranean Sea to the north, the Suez Canal to the east, and the Damietta Branch of the River Nile to the west border the northerly located Lake Manzala, which is located in the eastern portion of the Nile Delta. Dakahila and Sharkia Provinces' northern boundary is formed by the southern coasts of the lake (Montasir, 1937). Five governorates are served by Lake Manzala: Damietta, Port Said, Ismailia, Sharkiya, and Dakahliya (Figure 1).

2.2. Estimation of plant species

The current study is represented by 44 stands (area = 10 x 10 m) at three sites: site 1 represents the lake coast (22 stands), site 2 represents the lake islands (11 stands), and site 3 represents open water (11 stands). The stands were placed across the research region to cover a variety of habitats and to guarantee that a diverse range of vegetational variables was sampled. The Botany Department's Herbarium at Mansoura University's Faculty of Science received all of the samples. This study's taxonomy of living forms was based on Raunkiaer's [12] categorization scheme. For classification, identification, nomenclature, and floristic categories, Davis [13], Zohary [14], Täckholm [15], Meickle [16], Feinbrun-Dothan [17], and Boulos [18] were utilized

3. Results and Discussion

3.1. Floristic Composition and Distribution of Plant Species in the Study Area

The hydrophytes and canal bank species in Manzala Lake are presented in terms of presence estimates (P %). Table (1) presents the floristic composition of different habitats in Manzala Lake. These habitats are (Lake Shores, Lake Open Water, and Lake Islets). The total number of hydrophytes and canal bank species recorded in Manzala Lake was 55 species. These species can be classified into four major groups as follow:

a) Seven floating hydrophytes were recorded in Manzala Lake. These species are: *Azolla filiculoides*, *Eichhornia crassipes*, *Lemna gibba*, *Lemna minor*, *Ludwigia stolonifera*, *Marsilea aegyptiaca* and *Pistia stratiotes*. Out of these hydrophytes, *Eichhornia crassipes* has moderate ecological amplitude, as it has been recorded in most habitats with 58.97 % presence value. Where the other six species, namely: *Azolla filiculoides* (P =5.13%), *Lemna gibba* (P =15.38%), *Lemna minor* (P =7.69%), *Ludwigia stolonifera* (P =15.38%), *Marsilea aegyptiaca* (P= 5.13%) and *Pistia stratiotes* (P= 30.77%) showed narrow ecological amplitude. b) The submerged hydrophytes include two species, namely: *Ceratophyllum demersum* and *Potamogeton crispus*. *Ceratophyllum demersum* and *Potamogeton pectinatus* have narrow ecological amplitude (P = 23.08 and 12.82%, respectively.)

c) The emergent (reed) species are represented by sixteen taxa in Manzala Lake. Only one species has been recorded in three habitats namely; *Phragmites australis* is widely distributed (P = 92.31%). Out of these species, *Typha domingensis* has moderate ecological amplitude, as it has been recorded in most habitats with 51.28 % presence value. Where the other 14 species, namely: *Alternative sessile* (P =5.13%), *Bolboschoenus glaucus* (P =2.56%), *Cyperus alopecoroides* (P =7.69%), *Cyperus articulatus* (P =2.56%), *Cyperus laevigatus* (P =5.13%), *Echinochloa colona* (P =5.13%), *Echinochloa stagnina* (P =20.51%), *Juncus acutus* (P =10.26%), *Juncus rigidus* (P =28.21%), *Juncus subulatus* (P =5.13%), *Persicaria lapathifolia* (P =2.56%), *Persicaria salicifolia* (P =2.56%), *Rnunculus sceleratus* (P =12.82%) and *Saccharum domingensis* (P =10.26%) have narrow ecological amplitude.

d) The terrestrial plants were represented by 30 species in Manzala Lake. These species are typically either canal bank plants of cultivated regions or weed flora associated with field crops.. Two species namely: *Arthrocnemum macrostachyum* and *Halocnemum strobilaceum* have moderate ecological amplitude ($P = 58.97$ and 51.28% respectively). Other 28 species, namely: *Atriplex portulacoides* ($P = 12.82\%$), *Bassia indica* ($P = 25.64\%$), *Chenopodium murale* ($P = 15.38\%$), *Cynanchum acutum* ($P = 20.51\%$), *Limbarda crithmoides* ($P = 15.38\%$), *Suaeda pruinosa* ($P = 23.08\%$), *Tamarix nilotica* ($P = 38.46\%$) and *Zygophyllum coccineum* ($P = 12.83\%$) have narrow ecological amplitude

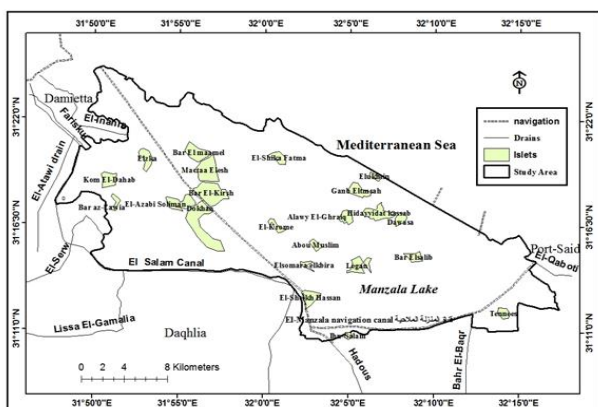


Fig 1: Map showing the study area.

3.2. Plant Life-Span in the Study Area

According to the life-span and as shown in Figure (2), the recorded species (55) growing in Manzala Lake can be classified into three major groups: perennials (39 species), biennials (1 species) and annuals (15 species). The plant life of Lake Shores habitat comprises 51 species, which can be divided into 36 perennials, 1 biennial and 14 annuals. Whereas in the Lake Open Water habitat, 11 species were recorded categorized into 10 perennials and 1 annual. Also 22 species were recorded in the Lake Islets habitat including 16 perennials, one species biennial and 5 species annuals.

Additionally, it is discovered that of all habitat types, lake shores have the largest floral diversity, followed by lake islets and lake open water.. It is also obvious that the terrestrial plants are the most frequent species in the different studied habitats, followed by the emergent species, then the floating hydrophytes and finally the submerged hydrophytes.

3.3. Plant Life-Forms in the Study Area

The recorded species of Manzala Lake are grouped under seven types of life-forms as follows: therophytes, geophytes, hemicryptophytes, chamaephytes, helophytes, nanophanerophytes and hydrophytes. The majority of plants are mainly therophytes (15 species), chamaephytes and helophytes (13 species for each), geophytes (11 species), hydrophytes (7 species), partially hemicryptophytes and nanophanerophytes (2 species for each) of the total recorded species (Figure 3).

It is clear that different habitats have different percentages of the life-form spectrum.. In the Lake shores habitat, the recorded species (59) can be classified into the following life-forms; therophytes (14), helophytes (13), geophytes (10), hydrophytes (7), chamaephytes (11), hemicryptophytes (2) and nanophanerophytes (2). In the Lake open water habitat, the recorded species (14) can be divided into; hydrophytes and nanophanerophytes (5 species for each), therophytes (1) and geophytes (3). The species which were recorded in the Lake Islets habitat (25 species) can be divided into; chamaephytes (9), helophytes (4), geophytes (4), therophytes (6), nanophanerophytes and hemicryptophytes (one species for each)

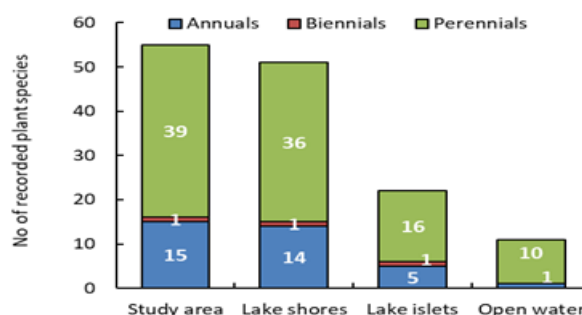


Fig 2. The study region's plant life span and three habitats

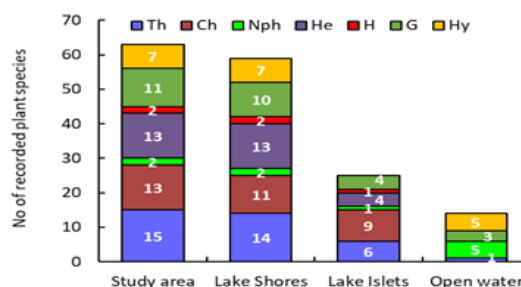


Fig 3. The study region's plant life form and three habitats

Table 1. Plant species documented of the different environments in the study region.

No.	Species	Family	Life span	Life form	Floristic category	Habitat types			P%
						Lake shores	Open water	Lake islets	
Hydrophytes									
Submerged hydrophytes									
1	Ceratophyllum demersum L.	Ceratophyllaceae	Perennials	Hy	COSM	+	+	-	23.08
2	Potamogeton pectinatus L.	Potamogetonaceae	Perennials	Hy	ME+IR-TR	+	-	-	12.82
Floating Hydrophytes									
3	Azolla filiculoides Lam.	Azollaceae	Annuals	Hy	COSM	+	-	-	5.13
4	Eichhornia crassipes (C. Mart.) Solms	Pontederiaceae	Perennials	Hy	NEO	+	+	-	58.97
5	Lemna gibba L.	Lemnaceae	Perennials	Hy	COSM	+	+	-	15.38
6	Lemna minor L.	Lemnaceae	Perennials	Hy	COSM	+	+	-	7.69
7	Ludwigia stolonifera (Guill. & Perr.) P.	Onagraceae	Perennials	He	S-Z	+	+	-	15.38
8	Marsilea aegyptiaca Willd.	Marsileaceae	Perennials	H, He	PAL	+	-	-	5.13
9	Pistia stratiotes L.	Araceae	Perennials	Hy	PAN	+	+	-	30.77
Emergent species									
10	Alternanthera sessilis (L.) DC.	Amaranthaceae	Perennials	He	PAN	+	-	-	5.13
11	Bolboschoenus glaucus (Lam.) S.G.Smith	Cyperaceae	Perennials	G	COSM	-	-	+	2.56
12	Cyperus alopecoroides L.	Cyperaceae	Perennials	He	PAN	+	-	-	7.69
13	Cyperus articulatus L.	Cyperaceae	Perennials	G, He	PAN	+	-	-	2.56
14	Cyperus Laevigatus L.	Cyperaceae	Perennials	G, He	PAN	+	-	+	5.13
15	Echinochloa colona (L.) Link)	Poaceae	Annuals	Th	PAN	+	-	-	5.13
16	Echinochloa stagnina (Retz.) P. Beauv	Poaceae	Perennials	G, He	PAL	+	+	-	20.51
17	Juncus acutus L.	Juncaceae	Perennials	He	ME+IR-TR+ER-SR	+	-	+	10.26
18	Juncus rigidus Desf.	Juncaceae	Perennials	He, G	ME+SA-SI+IR-TR	+	-	+	28.21
19	Juncus subulatus	Juncaceae	Perennials	He, G	ME+SA-SI+IR-TR	+	-	-	5.13
20	Persicaria lapathifolia (L.) Gray	Polygonaceae	Perennials	G	PAL	+	-	-	2.56
21	Persicaria salicifolia (Willd) Assenov	Polygonaceae	Perennials	G	PAL	+	-	-	2.56
22	Phragmites australis (Cav.) Trin. ex Steud	Poaceae	Perennials	G, He	COSM	+	+	+	92.31
23	Ranunculus sceleratus L.	Ranunculaceae	Annuals	Th	ME+IR-TR+ER-SR	+	+	-	12.82
24	Saccharum spontaneum L. Mant. Alt	Poaceae	Perennials	G, He	ME+PAL	+	+	-	10.26
25	Typha domingensis (Pers.) Poir. ex Steud	Typhaceae	Perennials	He	PAN	+	+	-	51.28
B) Terrestrial									
26	Arthrocnemum macrostachyum (Moreic.) K.Koch	Chenopodiaceae	Perennials	Ch	ME+SA-SI	+	-	+	58.97
27	Atriplex portulacoides L.	Chenopodiaceae	Perennials	Ch	ME+IR-TR+ER-SR	+	-	+	12.82
28	Atriplex prostrata Boucher ex DC.	Chenopodiaceae	Annuals	Th	ME+ER-SR+IR-TR	+	-	+	5.13
29	Bassia indica (Wight) A.J.Scott.	Chenopodiaceae	Annuals	Th	S-Z+IR-TR	+	-	+	25.64
30	Chenopodium album	Chenopodiaceae	Annuals	Th	COSM	+			2.56

	L.								
31	Chenopodium murale L.	Chenopodiaceae	Annuals	Th	COSM	+	-	+	15.38
32	Cynanchium acutum L.	Asclepiadiaceae	Perennials	H	ME+IR-TR	+	-	+	20.51
33	Cynodon dactylon (L.) Pers.	Poaceae	Perennials	G	COSM	+	-	-	10.26
34	Halocnemum strobilaceum (pall) M.Bieb	Chenopodiaceae	Perennials	Ch	ME+IR-TR+SA-SI	+	-	+	51.28
35	Heliotropium curassavicum L.	Boraginaceae	Perennials	Ch	NEO	-	-	+	5.13
36	Ipomoea carnea Jacq.	Convolvuliaceae	Perennials	Ch	Cult. & Nat.	+	-	-	2.56
37	Limbarda criethmoides (L.) Dumort.	Asteraceae	Perennials	Ch	ME+ER-SR+SA-SI	+	-	+	15.38
38	Malva parviflora L.	Malvaceae	Annuals	Th	ME+IR-TR	-	-	+	2.56
39	Mesembryanthemum crystallinum L.	Aizoaceae	Annuals	Th	ME+ER-SR	+	-	-	7.69
40	Mesembryanthemum nodiflorum L.	Aizoaceae	Annuals	Th	ME+SA-SI+ER-SR	+	-	-	5.13
41	Phyla nodiflora (L.) Greene	Verbenaceae	Perennials	Ch	PAN	+	-	-	2.56
42	Pluchea dioscoridis (L.) DC.	Asteraceae	Perennials	Nph	S-Z+SA-SI	+	-	-	7.69
43	Rumex dentatus L.	Polygonaceae	Annuals	Th	ME+ IR-TR +ER-SR	+	-	-	7.69
44	Salsola kalii L.	Convolvulaceae	Annuals	Th	COSM	+	-	-	2.56
45	Senecio glaucius L.	Asteraceae	Annuals	Th	ME+SA-SI+IR-TR	+	-	+	7.69
46	Sonchus oleraceus L.	Asteraceae	Annuals	Th	COSM	+	-	-	5.13
47	Spergularia maritima (L.) Griseb.	Caryophyllaceae	Biennials	Th	ER-SR+ME+IR-TR	+	-	+	5.13
48	Suaeda maritima	Chenopodiaceae	Annuals	Th	COSM	+	-	-	5.13
49	Suaeda pruinosa Lange	Chenopodiaceae	Perennials	Ch	ME	+	-	+	23.08
50	Suaeda veira Forssk. ex J.F. Gmel.	Chenopodiaceae	Perennials	Ch	ME+SA-SI+ER-SR	-	-	+	5.13
51	Symphyotrichum squamatum (Spreng.) Nesom	Asteraceae	Perennials	Ch	NEO	+	-	+	7.69
52	Tamarix nilotica (Ehrenb.) Bunge	Tamaricaceae	Perennials	Nph	S-Z+SA-SI	+	-	+	38.46
53	Zygophyllum aegyptium hosny	Zygophyllaceae	Perennials	Ch	ME	+	-	-	2.56
54	Zygophyllum album L.	Zygophyllaceae	Perennials	Ch	ME+SA-SI	+	-	+	5.13
55	Zygophyllum coccineum L.	Zygophyllaceae	Perennials	Ch	SA-SI+S-Z	+	-	-	12.82
Number of stands					39	22	8	9	
Number of perennials					39	36	10	16	
Number of biennials					1	1	0	1	
Number of annuals					15	14	1	5	
Total number of recorded species					55	51	11	22	

Abbreviations: P: Presence

Life-form; Nph.: Nano-phanerophytes, Ch.: Chamaephytes, H.: Hemi-cryptophytes, G.: Geophytes, He.: Helophytes, Hy: Hydrophytes, Th: Therophytes; Chorotype; COSM: Cosmopolitan, PAN: Pantropical, NEO: Neotropical, PAL: Palaeotropical, IR/TR: Irano-Turanian, S/Z: Sudano-Zambezian, Cult. & Nat.: Cultivated and Naturalized, ME: Mediterranean, ER/SR: Euro-Siberian, SA/SI: Saharo-Sindian.

3.4. The Floristic Analysis of the Study Area

There are 55 flowering plant species in Manzala Lake that have been recorded, and they are from 41 genera and 26 families (Table 2). These families are as follow; Chenopodiaceae (10 species), Asteraceae (5

species), Poaceae (5 species), Cyperaceae (4 species), Juncaceae, Polygonaceae and Zygophyllaceae (3 species for each). Each of the remaining families was represented either by two or one species. Floristically and as shown in Table (2), the most common floristic

elements of the Chenopodiaceae are Pluri-regional (4 species), Cosmopolitan (3 species), Bi-regional (2 species) and Mediterranean (one species).

In Asteraceae, the most common chorotypes are Pluri-regional (2 species), Cosmopolitan, Bi-regional and Neotropical (one species for each). In Poaceae, the most common elements are Cosmopolitan (2 species), Palaetropical, Pantropical and Bi-regional (one species for each). In Cyperaceae, the most common chorotypes are Pantropical (3 species) and Cosmopolitan (only one species). In Juncaceae, all elements are Pluri-regional (3 species). The most common elements in Polygonaceae are palaeotropical (2 species) and Pluri-regional (one species). In Zygophyllaceae, the most common chorotypes are Bi-regional (2 species) and Mediterranean (one species). While, the other families (with less than 3 species) comprised different types of floristic elements which are generally represented by few number of species.

The floristic analysis of Manzala Lake and as shown in Table (3) revealed that 13 species or about 23.64 % of the total number of

recorded species are Pluri-regional taxa. Other taxa are either Cosmopolitan (12 species = 21.82%), Bi-regional (11 species = 20%), Pantropical (8 species = 14.55%), Palaetropical (4 species = 7.27%), Neotropical (3 species = 5.45%), Mediterranean (2 species = 3.64%). But Sudano-Zambezian and Cultivated and Naturalized are represented within the lowest number (only one species for each = 1.82 %)

4. Conclusion

The species in the study region are notable because they provide a variety of goods and services to the neighbourhood (*Tamariix nilotica*, *Phragmites australis*, *Alhagii graecorum*, *Atriplex halimus*, *Panicum turgidum*, *Typhla domingensis*, etc.). Therefore, long-term management of plant diversity in this area is necessary to reduce severe human impacts, such as ongoing land reclamation, which harms natural ecosystems, especially salt marshes and sand formations found on sand bars and some islands (such as sand sheets, hillocks, and dunes) (e.g., Al-Kawm Al-Akhdar). Many uncommon species that are not found elsewhere in the region can be found in these settings.

Table 2. The main phytochorotype of the families in the study region.

Family	Genus	Species	COSM	PAL	NEO	PAN	Pluri-regional elements	Bi-regional elements	ME	S-Z	Cult. & Nat.
Chenopodiaceae	6	10	3				4	2	1		
Asteraceae	5	5	1		1		2	1			
Poaceae	4	5	2	1		1		1			
Cyperaceae	2	4	1			3					
Juncaceae	1	3					3				
Polygonaceae	2	3		2			1				
Zygophyllaceae	1	3						2	1		
Aizoaceae	1	2					1	1			
Convolvulaceae	2	2	1								1
Lemnaceae	1	2	2								
Amaranthaceae	1	1				1					
Araceae	1	1				1					
Asclepiadaceae	1	1						1			
Azollaceae	1	1	1								
Boraginaceae	1	1			1						
Caryophyllaceae	1	1					1				
Ceratophyllaceae	1	1	1								
Malvaceae	1	1						1			
Marsileaceae	1	1		1							
Onagraceae	1	1								1	
Pontederiaceae	1	1			1						
Potamogetonaceae	1	1						1			
Ranunculaceae	1	1					1				
Tamaricaceae	1	1						1			
Typhaceae	1	1				1					
Verbenaceae	1	1				1					
Total	41	55	12	4	3	8	13	11	2	1	1
			21.82	7.27	5.45	14.55	23.64	20.00	3.64	1.82	1.82

Table 3. Species number and % of various floristic groups in the research area's distinct habitat types.

Floristic category	Study area		Lake Shore		Lake Islets		Open Water		Geographical distribution
	No.	%	No.	%	No.	%	No.	%	
COSM	12	21.82	11	21.57	3	13.64	4	36.36	World wide
PAL	4	7.27	4	7.84	-	-	1	9.09	
NEO	3	5.45	2	3.92	2	9.09	1	9.09	
PAN	8	14.55	8	15.69	1	4.55	2	18.18	
ME.+IR.-TR.+ER.-SR	6	10.91	6	11.76	4	18.18	1	9.09	Pluri-regional elements
ME.+IR-TR.+SA-SI.	4	7.27	4	7.84	3	13.64	-	-	
ME.+ER-SR.+SA-SI.	3	5.45	2	3.92	2	9.09	-	-	
ME+PAL	1	1.82	1	1.96	-	-	1	9.09	Bi-regional elements
ME+IR-TR	3	5.45	2	3.92	2	9.09	-	-	
ME+ER-SR	1	1.82	1	1.96	-	-	-	-	
ME+SA-SI	2	3.64	2	3.92	2	9.09	-	-	
IR-TR+S-Z	1	1.82	1	1.96	1	4.55	-	-	
SA-SI+S-Z	3	5.45	3	5.88	1	4.55	-	-	
ME	2	3.64	2	3.92	1	4.55	-	-	Mono-regional elements
S-Z	1	1.82	1	1.96	-	-	1	9.09	
Cult. & Nat.	1	1.82	1	1.96	-	-	-	-	
Total	55	100	51	100	22	100	11	100	

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