MANSOURA JOURNAL OF BIOLOGY
Official Journal of Faculty of Science, Mansoura University, Egypt
E-mail: scimag@mans.edu.eg ISSN: 2974-492X

# Floristic composition of the Plant Communities Associated with *Zilla spinosa*, Eastern Desert, Egypt

***Yassmen G. Abdelkadir*[1], *El-Sayed F. El-Halawany* [1], *Salama A. Salama*[2], *Yasser A El-Amier* [1] ***

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

[2] *Zoology Department, Entomology, Faculty of Science, Damanhour University*

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

**Received:30/10/2022**
**Accepted: 11/11/2022**

**Abstract** The current study investigates the floristic aspects of plant communites associated with *Zilla spinosa*; including a list of plant species, duration, life-form spectra, and phytochorotype of the plant life in three wadis of Eastern Desert (Wadi Hagoul, Wadi Araba and wadi El-Rashrash). There were 92 species in the total number of recorded taxa studied in this work, which were divided into 77 genera and 27 families. Asteraceae comprises 20 species of the total recorded plant species, followed by family Boraginaceae 11 species, Poaceeae 10 species, Fabaceae 7 species, Chenopodiaceae and Zygophyllaceae comprise 5 species each. The maximum number of species (84) was documented in the inland desert of Wadi Araba, while the Wadi Hagoul was represented by 57 species. According to chorotype, the total number of recorded species were Mediterranean taxa and Saharo-Sindian element was highly represented.

**keywords**: *Zilla* species; Desert; Floristic, Vegetation, Wadi Hagoul.

## 1.Introduction

Arid and semi-arid zones are rich in wildlife and stunning landscapes. This is an interesting area that the management of countries cannot ignore but which has not been adequately taken into account so far (Foggin, 2018; Hobohm et al., 2021). The world's semiarid and subhumid regions are frequently referred to as dryland farming areas. Agriculture in arid regions is mostly restricted to animal grazing, and even in semiarid areas, a major portion of the land is exclusively utilised for grazing. As a result, agricultural in dryland areas is far more extensive than dryland farming, especially in terms of area. Roughly 4% of the Earth's land area, or 4 billion hectares, is made up of the semiarid and subhumid zones, which make up about 27% of the planet's surface. However, only approximately 10% of this land is actually cultivated each year (Grainger, 1996; Stewart and Thapa, 2016; Sidiropoulos et al., 2021).

The region of the Eastern Desert known as the Sahara Desert is located east of the Nile River. It extends from the Nile Valley in the east to the Gulf of Suez and the Red Sea, covering around 223,000 km2, or 21% of Egypt's total geographic area. The Eastern Desert is higher than the Western-Desert because its main feature is a spine of tall, steep mountains that run parallel to and not too far from the shore. It is also known as the Red Sea Hills (El-Khouly and Shawky, 2017; Elkhouly et al., 2021).

One of the main angiosperm families is the Brassicaceae, also known as the mustard family. While certain species, particularly those of the genus Brassica, have undergone extensive domestication and are prized as food crops, others are planted as ornamental plants because of their eye-catching cross-shaped blooms. The leaves and shoots of plants are used in asthma, cough and bleeding piles (Appel and Al-Shehbaz, 2003; Al-Shehbaz and Warwick, 2006). In addition to the family's varying geographic distribution across the northern and southern hemispheres, reports of its occurrence in the tropics' hilly and alpine areas have been made (Koch and Kiefer, 2006; Anjum et al., 2012). Brassicaceae members generate secondary metabolites that are not only species- and genus-specific but also

family-specific (Angelini et al., 1998; Clauss et al., 2006; Bednarek, 2012).

One of the most prevalent shrub species in the family Brassicaceae is *Zilla spinosa* Forsk (Cruciferea). Different regions of the Egyptian desert and Saudi Arabia support *Z. spinosa* growth (Heneidy and Bidak, 2001). Due to its historic usage in treating kidney and gall bladder stones, this plant is regarded as one of the most significant medicinal herbs (Heneidy and Bidak, 2001).

This study's main objective is to look at the floristic traits of wild plants related to *Zilla spinosa*, including their duration, life-form spectra, registers of wild taxa, and phytochorotype.

## 2. Materials and Methods

### 2.1. Study area

The Eastern Desert, which spans from the Nile Valley to the Gulf of Suez and the Red Sea, makes up around 21% of Egypt's total land area. The Galalah Desert in Egypt, which stretches east of the Nile Delta, is home to Wadi Hagoul and the Cairo-Suez Desert Road. These two regions mimic the xeric ecology of nature, and the bulk of the vegetation is xerophytic and psammophytic [10] (Figure 1).

In Egypt's Suez region, there is a hydrographic valley called Wadi Hagul. In the Eastern Desert, it is one of the most remarkable and interesting wadis. It contains most Egypt's potential project regions for reducing the overpopulation issue in the Nile Delta's constrained area (Seleem and Aboulela, 2011). Arid Wadi Araba runs from Za'farana on the Red Sea coast to the Nile valley to the north of Beni Souef. The Eastern Desert's major Eocene limestone plateau is located west of Wadi Araba, which has a width of around 30 km (Abu Al-Izz, 1971; Said, 1990). A depression called Wadi El-Rashrash can be found in Egypt's Eastern Desert (also known as the Helwan Desert). The wadi basin's maximum length, including meanders and tributaries, is 67 km. A wadi is a valley or ravine that is bordered by relatively steep banks, becomes a river during the rainy season, and is distinguished by a few abandoned stands (Girgis, 1962).

### 2.2. Estimation of plant species

In the present investigation, Site 1 represented the Western shore (25 stands), while Site 2 represented Wadi Hgoul, Eastern Desert (20 stands). The stands were spread out across the study region to ensure sampling of a wide variety of vegetational variations and to cover the different ecosystems. All of the samples that were gathered are kept in the herbarium at Mansoura University's Faculty of Science. The taxonomy of living forms used in this study was built on Raunkiaer's classification system [11]. Davis [12], Zohary [13], Täckholm [14], Feinbrun-Dothan [15], and Boulos [16] were used for categorization, identification, nomenclature, and floristic categories.)

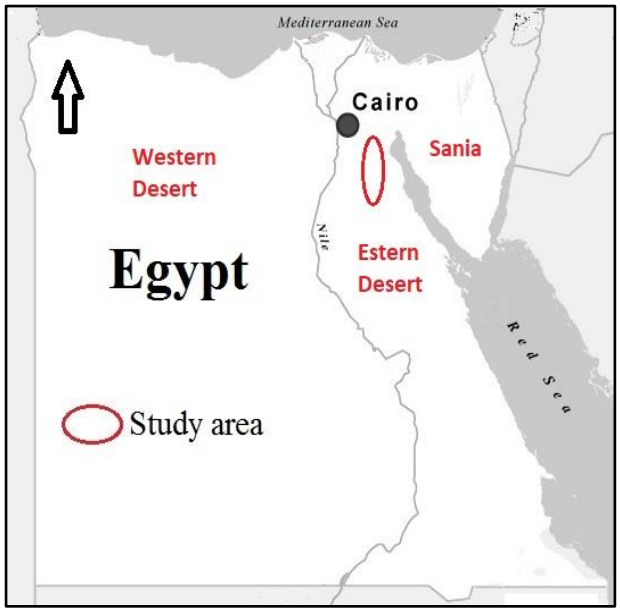


**Fig 1:** Map of Egypt showing the study area.

## 3. Results and Discussion

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

Table (1) shows the floristic composition of plant species associated with *Zilla spinosa* in three Wadis (Northern sector of Eastern desert) namely: Wadi Hagoul, Wadi El-Rashrash and Wadi Araba, 51 stands have been selected for sampling vegetation

### 1 .1. Plant Lifespan in the Study zone

The records of wild plants in the study area are presented in Table (1), which showed that, the overall number of plant taxa in the current study is 92. These species are classified as shown in Figure (2) into three major groups: 35

annual species (38.04%), two biennial species (2.13%) and 55 perennial species .(%58.51)

### 1.2. Plant Life-Forms in the Study zone

According to the description and classification of life-forms (Raunchier, 1934), the life-forms of the wild plants recorded in the present study are grouped under seven types as follows: therophytes, geophytes, nanophanerophytes, hemicryptophytes, chamaephytes, phanerophyes and parasite (Figure 3). The majority of the recorded species are therophytes (39.36%) followed by chamaephytes (31.91%) then hemicryptophytes (11.70%), phanerophytes (10.64%) and geophytes (4.26%). The lowest value of life-forms is recorded as helophytes and parasite which attained value of (1.06% each).

**Table 1.** Vegetation composition of the taxa of the different habitats in the study region

| .Plant Species | Family | Life form | Floristic analysis |
|---|---|---|---|
| **Perennial** | | | |
| Acacia tortilis **(Forssk.) Hayne** | Fabaceae | Ph | S-Z |
| Achillea fragrantissima **(Forssk.)Sch.Bip.** | Asteraceae | Ch | SA-SI+IR-TR |
| Artemisia judiaca **L.** | Asteraceae | Ch | SA-SI |
| Aerva javanica **(Burm.F.) Juss. ex Schult.** | Amaranthaceae | Ch | SA-SI + S-Z |
| Alkanna lehmanii **(Tin.) A.DC.** | Boraginaceae | H | ME |
| Anabasis articulata **(Forssk.) Moq.** | Chenopodiaceae | Ch | SA-SI+IR-TR |
| Artemisia monosperma **Delile.** | Asteraceae | Ch | SA-SI+ME |
| Astragalus spinosus **(Forssk.) Muschl.** | Fabaceae | Ch | SA-SI + IR-TR |
| Atractylis carduus **(Forssk.) C.Chr**. | Asteraceae | H | SA-SI+ME |
| Calligonum polygonoides **L**. subsp. comosum **(L′Hér.)Soskov** | Polygonaceae | Nph | IR-TR+SA-SI |
| Calotropis procera **(Willd.) R.Br.** | Asciepiadaceae | Ph | SA-SI + S-Z |
| Cistanche phelypaea **(L.) Cout.** | Orobanchaceae | P, G | ME+SA-SI |
| Cleorne droserifolia **(Forssk.) Delile** | Cleomaceae | Ch | SA-SI + IR-TR |
| Crotalaria aegyptiaca **Benth.** | Fabaceae | Ch | SA-SI |
| Cyondon dactylon **(L.)Pers**. | Poaceae | G | COSM |
| Deverra tortuosa **(Desf.)DC.** | Apiaceae | Ch | SA-SI |
| Diplotaxis harra **(Forssk.) Boiss.** | Brassicaceae | Ch | ME+ SA-SI |
| Echinops spinosus **L**. | Asteraceae | H | ME+SA-SI |
| Fagonia arabica **L**. | Zygophyllaceae | Ch | SA-SI |
| Fagonia mollis **Delile**. | Zygophyllaceae | Ch | SA- SI |
| Farsetia aegyptia **Turra**. | Brassicaceae | Ch | S-Z+SA-SI |
| Forsskaolea tenacissima **L**. | Urticaceae | H | SA-SI + S-Z |
| Pulicaria incisa **(Lam.) DC.** | Asteraceae | Ch | SA-SI |
| Gypsopila capillaris **(Forssk.)C.Chr** | Caryophyllaceae | H | IR-TR+SA-SI |
| Haloxylon salicornicum **(Moq.)Bunge ex Boiss**. | Chenopodiaceae | Ch | SA-SI |
| Haplophyllum tuberculatum **(Forssk.) Juss.** | Rutaceae | H | SA-SI |
| Heliotropium arbainense **Fresen**. | Boraginaceae | Ch | SA-SI |
| Heliotropium digynum **(Forssk.) C.Chr.** | Boraginaceae | Ch | SA-SI |
| Hyoscyamus muticus **L**. | Solanaceae | Ch | SA-SI |
| Iphiona mucronata **(Forssk.)Asch. &Schweinf.** | Asteraceae | Ch | SA-SI |
| Kickxia aegyptiaca **(L.)Nábelek.** | Scrophulariaceae | ch | ME+SA-SI |
| Lasiurus scindicus **Henrard.** | Poaceae | G | SA-SI+S-Z |
| Launaea mucronata **(Forssk.)Muschl.** | Asteraceae | H | ME+SA-SI |
| Launaea nudicaulis **(L.)Hook.f.** | Asteraceae | H | SA-SI |
| Launaea spinosa **(Forssk.)Sch.Bip. ex Kuntze.** | Asteraceae | Ch | SA-SI |
| Lavandula coronopifolia **Poir.** | Labiatae | Ch | SA-SI |
| Leptadenia pyrotechnica **(Forrsk.)Decne**. | Asclepiadaceae | Nph | SA-SI |
| Lycium shawii **Roem. & schult**. | Solanaceae | Nph | SA-SI+S-Z |
| Nauplius graveolens **(Forssk.)Wilklund** | Asteraceae | Ch | SA-SI |
| Nitraria retusa **(Forssk.) Asch**. | Nitrariaceae | Ph | SA-SI |
| Ochradenus baccatus **Delile**. | Resedaceae | Nph | SA-SI |
| Panicum turgidum **Forssk**. | Poaceae | H | SA-SI |
| Pergularia tomentosa **L**. | Asclepiadaceae | Ch | SA-SI |
| Phragmites australis **(Cav.) Trin.ex Steud**. | Poaceae | G, He | COSM |
| Polycarpaea repens **(Forssk.) Asch.** | Caryophyllaceae | Ch | SA-SI |
| Pulicaria undulata **(L.) C.A.Mey.** | Asteraceae | Ch | SA-SI+S-Z |
| Retama raetam **(Forssk.) Webb&Berthel**. | Fabaceae | Nph | SA-SI |
| Scophularia deserti **Delile** | Scrophulariaceae | Ch | SA-SI |
| Spergularia media **(L.) C. Presl** | Caryophyllaceae | H | ME+IR-TR+ER-SR |
| Tamarix aphylla **(L.) H. Karst**. | Tamaricaceae | Nph | SA-SI+S-Z |

| | | | |
|---|---|---|---|
| Tamarix nilotica **(Ehrenb.) Bunge**. | Tamaricaceae | Nph | SA-SI |
| Trichodesma africanum **(L.) R.Br**. | Boraginaceae | H | S-Z+SA-SI |
| Zilla spinosa **(L.) Prantl.** | Brassicaceae | Ch | SA-SI |
| Zygophyllum coccineum **L**. | Zygophyllaceae | Ch | SA-SI |
| Zygophyllum decumbens **Delile**. | Zygophyllaceae | Ch | SA-SI |
| **Biannuals** | | | |
| Centaurea aegyptiaca **L**. | Asteraceae | Th | SA-SI |
| Launaea capitata **(Spreng)Dandy** | Asteraceae | Th | S-Z+SA-SI |
| **Annuals** | | | |
| Anthemis cotula **L**. | Asteraceae | Th | ME |
| Astragalus bombycinus **Boiss**. | Fabaceae | Th | SA-SI+IR-TR |
| Bassia muricata **(L.)Asch**. | Chenopodiaceae | Th | IR-TR+SA-SI |
| Atriplex lindleyi **Moq**. subsp. inflate **(F.Muell.)Wilson**. | Chenopodiaceae | Th | ME+IR-TR+ER-SR |
| Chenopodium murale **L**. | Chenopodiaceae | Th | COSM |
| Cleome amblyocarpa **Barratte&Murb.** | Cleomaceae | Th | SA-SI |
| Diplotaxis acris **(Forssk.) Boiss.** | Brassicaceae | Th | SA-SI |
| Emex spinosa **(L.)Campd.** | Polygonaceae | Th | ME+SA-SI |
| Erodium laciniatum **(Cav.) Wild**. | Geraniaceae | Th | ME |
| Erysimum repandum **L**. | Brassicaceae | Th | ME+IR-TR+ER-SR |
| Euphorbia retusa **Forssk**. | Euphorbiaceae | Th | SA-SI |
| Herniaria hemistemon **J**.**Gay** | Caryophyllaceae | Th | ME+SA-SI |
| Hordeum murinum **L**. subsp. leporinum **(link) Arcang**. | Poaceae | Th | ME+IR-TR+ER-SR |
| Hordeum spontaneum **K. Koch** | Poaceae | Th | ME+IR-TR |
| Ifloga spicata **(Forssk.) Sch.Bip**. | Asteraceae | Th | SA-SI |
| Lactuca serriola **L** | Asteraceae | Th | ME+IR-TR+ER-SR |
| Lolium multiflorum **Lam**. | Poaceae | Th | ME+IR-TR+ER-SR |
| Lotus glinoides **Delile**. | Fabaceae | Th | S-Z |
| Malva parvifolra **L**. | Malvaceae | Th | ME+IR-TR |
| Matthiola longipetala **(Vent.)DC.** | Brassicaceae | Th | ME+IR-TR |
| Mesembryanthemum forsskaolii **Hochst. Ex Boiss**. | Aizoaceae | Th | SA-SI |
| Neurada procumbense **L**. | Neuradaceae | Th | SA-SI+S-Z |
| Parapholis incurva **(L.)C.E.Hubb.** | Poaceae | Th | ME+IR-TR+ER-SR |
| Plantago ciliata **Desf**. | Plantaginaceae | Th | SA-SI+IR-TR |
| Plantago lagopus **L**. | Plantaginaceae | Th | ME+IR-TR |
| Plantago notata **Lag**. | Plantaginaceae | Th | IR-TR+SA-SI |
| Plantago ovata **Forssk**. | Plantaginaceae | Th | IR-TR+SA-SI |
| Poa annua **L**. | Poaceae | Th | COSM |
| Reichardia tingitana **(L.) Roth**. | Asteraceae | Th | ME+IR-TR |
| Reseda decursiva **Forssk**. | Resedaceae | Th | SA-SI |
| Rumex vesicarius **L**. | Polygonaceae | Th | ME+SA-SI+ S-Z |
| Senecio glaucus **L**. | Asteraceae | Th | ME+IR-TR+SA-SI |
| Trigonella stellata **Forssk**. | Fabaceae | Th | SA-SI+IR-TR |
| Volutaria lippii **(L.) Cass. ex Maire** | Asteraceae | Th | SA-SI |
| Zygophyllum simplex **L**. | Zygophyllaceae | Th | SA-SI |

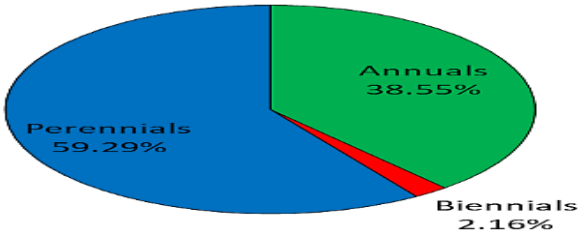


**Fig2.** Plant duration in the study place.

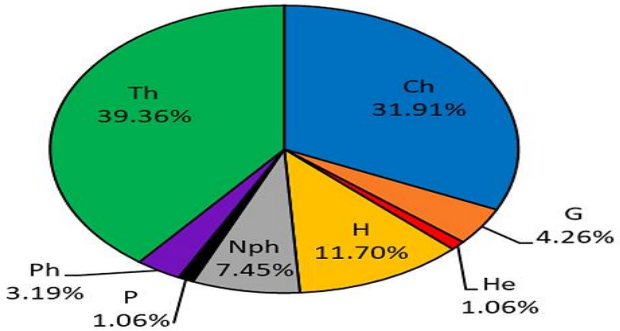


**Fig 3.** Plant listed life-form in the study place

### 3.4. The Chorotype of the Study Zone

The total number of the recorded plant taxa assessed in the current study is 94 species belonging to 77 genera and related to 27 families. Table (2) showed that, the family Asteraceae comprises 20 species (21.27%) of the total recorded plant species, followed by family Boraginaceae 11 species (11.70%), Poaceeae 10 species (10.63%), Fabaceae 7 species (7.44%), Chenopodiaceae and Zygophyllaceae comprise 5 species each (5.319 %), Caryophyllaceae and Plantiginaceae 4 species each (4.255), Asciepiadaceae, Polygonaceae each 3 species (3.19%). The remaining families (17) were represented by either two or one species

The floristic categories of the plant life in the study space are displayed in Table (2). The most common floristic elements of the family Asteraceae are Saharo-Sindian (9 species), Biregional (8 species), Pluriregional (2 species) and Mediterranean (one species). In Boraginaceae the floristic categories were Biregional, Saharo-Sindian (4 species each), Mediterranean and Pluriregional (one species each). In Poaceeae, the chorotypes were Pluriregional (3 species), Cosmopolitan (3 species), Biregional (2 species) and Saharo-Sindian (one species). The floristic elements in Fabaceae were Biregional (3species), Saharo-Sindian and Sudano-Zamdzeian are represent by two species each. Chenopodiaceae was represented by 5 species distributed in four floristic elements: Cosmopolitan, Pluriregional and Saharo-Sindian are representing only one species each, and Biregional (2 species). In Zygophylaceae, the floristic categories are Saharo-Sindian (5 species). The common floristic categories in Caryophyllaceae were Pluriregional and Saharo-Sindian is represent only one species and Biregional (2 species). In Plantaginaceeae, the chorotypes were Biregional (4 species). The most frequent floristic components of the family Asciepiadaceae are Biregional is represent by only one species and Saharo-Sindian (2 species). In Polygonaceae, the floristic categories were Pluriregional (one species) and Biregional (2 species). The remaining families (17), on the other hand, were represented by two or fewer species.

Table ( 3 ) reveals also that, 27 species or represented 28.72% of the total number of recorded species are Mediterranean taxa. These taxa are either Pluriregional (10 species = 10%), Biregional (14 species = 14.89%) or Monoregional (3 species= 3.19 %). It has been found Saharo-Sindian 60 species represented by 63.83% these taxa are either Monoregional (37 species = 61.67%), Biregional (21 species = 35%) and Pluriregional (2 species = 3.33%). Additionally, 4 species or represented by 4.26% Cosmopolitan and one Neotropical (1.06%). Finally, two species or represented 2.13% of the overall number of recorded taxa are Sudano-Zamdzeian.

**Table 2.** The dominant chorotype among the research zone's families.

| No. | Families | Genus | Species | COSM | NEO | Plurioregional | Biregional | SA-SI | ME | S-Z |
|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Asteraceae | 16 | 20 | | | 2 | 8 | 9 | 1 | |
| 2 | Boraginaceae | 8 | 10 | | | 1 | 4 | 4 | 1 | |
| 3 | Poaceeae | 8 | 9 | 3 | | 3 | 2 | 1 | | |
| 4 | Fabaceae | 6 | 7 | | | | 3 | 2 | | 2 |
| 5 | Chenopodiaceae | 5 | 5 | 1 | | 1 | 2 | 1 | | |
| 6 | Zygophyllaceae | 3 | 5 | | | | | 5 | | |
| 7 | Caryophyllaceae | 4 | 4 | | | 1 | 2 | 1 | | |
| 8 | Plantaginaceeae | 1 | 4 | | | | 4 | | | |
| 9 | Asciepiadaceae | 3 | 3 | | | | 1 | 2 | | |
| 10 | Polygonaceae | 3 | 3 | | | 1 | 2 | | | |
| 11 | Cleomaceae | 1 | 2 | | | | 1 | 1 | | |
| 12 | Resedaceae | 2 | 2 | | | | | 2 | | |
| 13 | Scrophulariaceae | 2 | 2 | | | | 1 | 1 | | |
| 14 | Solanaceae | 2 | 2 | | | | 1 | 1 | | |
| 15 | Tamaricaceeae | 1 | 2 | | | | 1 | 1 | | |
| 16 | Aizoaceae | 1 | 1 | | | | | 1 | | |
| 17 | Amaranthaceae | 1 | 1 | | | | 1 | | | |
| 18 | Apiaceae | 1 | 1 | | | | | 1 | | |
| 19 | Euphorbiaceae | 1 | 1 | | | | | 1 | | |
| 20 | Geraniaceae | 1 | 1 | | | | | | 1 | |
| 21 | Labiatae | 1 | 1 | | | | | 1 | | |
| 22 | Malvaceae | 1 | 1 | | | | 1 | | | |
| 23 | Neuradaceae | 1 | 1 | | | | 1 | | | |
| 24 | Nitrariaceae | 1 | 1 | | | | | 1 | | |
| 25 | Orobanchaceae | 1 | 1 | | | | 1 | | | |
| 26 | Rutaceae | 1 | 1 | | | | | 1 | | |
| 27 | Urticaceae | 1 | 1 | | | | 1 | | | |
| **Total** | | **77** | **92** | **4** | **0** | **9** | **37** | **37** | **3** | **2** |
| **Percentage** | | | | **4.26** | **1.06** | **4.26** | **0.00** | **9.57** | **39.36** | **39.36** |

**Table 3.** In the various habitat types in the research zone, the number of taxa and the ratio of various chorotypes.

| Floristic category | Study area | | Geographical distribution |
|---|---|---|---|
| | No. | % | |
| COSM | 4 | 4.26 | World wide |
| NEO | 1 | 1.06 | |
| ME+IR/TR+ER/SR | 8 | 8.51 | Pluriregional elements |
| ME+IR/TR+SA/SI | 1 | 1.06 | |
| ME+SA/SI+S/Z | 1 | 1.06 | |
| ME+IR/TR | 5 | 5.32 | Biregional elements |
| ME+SA/SI | 9 | 9.57 | |
| IR/TR+SA/SI | 12 | 12.77 | |
| ME | 3 | 3.19 | Mono-regional elements |
| SA-SI | 37 | 39.36 | |
| S-Z | 2 | 2.13 | |
| Total | 94 | 100.00 | |

## 4. Conclusion

By using renewable resources from both cultivated and uncultivated regions, Egypt is striving to increase the production of food, forage, and medicinal supplies. In the current study, 92 identified plant species-distributed among 89 genera and 27 families were reported. Most of the recorded species were of taxa from the Mediterranean. Additionally, 65 species were found to include a sizable Saharo-Sindian component. Utilizing important natural resources wisely is crucial, including untamed wildlife, forests, fisheries, and the land, water, and air.

## 5. References


1. Reiss, S.P., (1999). The desert environment. ACM Transactions on Software Engineering and Methodology (TOSEM), **8(4),** pp.297-342.
2. El-Shirbeny, M.A., Ali, A.M., Khdery, G.A., Saleh, N.H., Afify, N.M., Badr, M.A. and Bauomy, E.M., (2021). Monitoring agricultural water in the desert environment of New Valley Governorate for sustainable agricultural development: a case study of Kharga. Euro-Mediterranean *Journal for Environmental Integration*, **6(2),** pp.1-15.
3. Hesp, P.A., (1991). Ecological processes and plant adaptations on coastal dunes. *Journal of arid environments*, **21(2),** pp.165-191.
4. Batanouny, K.H., (2000). Plants in the deserts of the Middle East. Springer Science & Business Media.
5. Zahran, M. A., & Willis, A. J. (2009). The Sinai Peninsula. In The Vegetation of Egypt (pp. 213-249). Springer, Dordrecht.
6. Ghodeif, K., Grischek, T., Bartak, R., Wahaab, R. and Herlitzius, J., (2016). Potential of river bank filtration (RBF) in Egypt. Environmental Earth Sciences, **75(8),** pp.1-13.
7. Zahran, M.A., El-Demerdash, M.A. and Mashali, I.A. (1990). Vegetation types of the deltaic Mediterranean coast of Egypt and their environment. *J. Veg. Sci*., **1**, 305–310.
8. Zahran, M.A. and El-Amier, Y.A., (2014). Ecology and establishment of fiber producing taxa naturally growing in the Egyptian deserts. *Egyptian Journal of Basic and Applied Sciences*, **1(3-4),** pp.144-150.
9. Zahran, M.A., El-Demerdash, M.A. and Mashali, I.A. (1985). On the ecology of the deltaic coast of the Mediterranean Sea, Egypt. I. General Survey. Proc. Egypt. Bot. Soc. Ismailia Conf., **4**, 1392–1407.
10. Sultan, M., Sturchio, N.C., Gheith, H., Hady, Y.A. and El Anbeawy, M., (2000). Chemical and isotopic constraints on the origin of Wadi El-Tarfa ground water, eastern desert, Egypt. Groundwater, **38(5),** pp.743-751.
11. Raunkięr, C (1934-1937). "Plant life forms". Clarendon Press..
12. Davis, P. H. (ed.) (1965, 1967, 1970,1972, 1975, 1978, 1982, 1984&1985). Flora of Turkey and the East Agean Islands. Vols. **1,2,3,4,5,6,7,8&9**. Edinburgh Univ. Press.
13. Zohary, M. (1996 and 1972) Flora Palestine. Vols. **1&2**. The Israel Academy of Science and Humanities, Jerusalem..
14. Meikle, R.D. (1977 & 1985). Flora of Cyprus. Vols. **1** and **2**. Bentham-Maxon Trust, Royal Botanic Gardens, Kew.
15. Feinbrun-Dothan, N. (1978&1986). Flora Palaestina. Parts 3&4. The Israel Academy of Sciences and Humanities, Jerusalem.
16. Boulos, L. (1999-2005) "Flora of Egypt. (Vol. **1-4**). Al Hadara Publishing, Cairo,)