Journal of Environmental Sciences, 2015; Vol. 44, No. 4 : 589-609

# ENDEMIC SPECIES IN SINAI PENINSULA, EGYPT, WITH PARTICULAR REFERENCE TO SAINT KATHERINE PROTECTORATE: I- ECOLOGICAL FEATURES

**Zahran M. A.[1]; Amer M. Wafaa[2]; Afiah A. Samy[3]; and Ghaly N. Omran[4]**

[1]*Botany Dept., Faculty of Science, Mansoura Univ., Egypt.*

[2]*Botany and Microbiology Dept., Faculty of Science, Cairo Univ., Egypt.*

[3]*Plant Genetic Resources Dept., Desert Research Center, Egypt.*

[4]*Ecology and Ranges Dept., Desert Research Center, Egypt.*

## ABSTRACT

*Endemic taxa are usually rare and restricted to geographical regions, so they deserve special attention for their conservation. This study revealed that: there are 28 taxa are endemic to Sinai Peninsula, 17 taxa were occurring in South Sinai, 12 out of these taxa are included in this study. The 12 studied endemic taxa are growing in four types of habitats: wadi bed, gorge, slope and basin (farsh). Gorge habitat is the richest (10 taxa from 12 studied taxa) followed by slope (8 taxa), wadi bed (7 taxa) and basins (6 taxa). Phlomis aurea has the highest presence value, (97.2%), while Silene leucophylla, Ballota kaiseri, Primula boveana and Rosa arabica are the rarest endemic species with the lowest presence values (2.7, 2.7, 13.8 and 22.2%), respectively. Farsh Rummana location contains the highest number of endemic taxa, (9 taxa) representing (75%) of the studied taxa, followed by Wadi Talla and Wadi Tinya which contain 8 taxa, each representing (66.66%). The lowest number of endemic (2 taxa) occurs in four locations namely: Farsh Safsafa, Kiniset El Homar, Sad Abu Hbeig and Loger representing (16.66%) of the studied taxa. The recorded endemic species are belonging to three different life forms: hemicryptophyte (50%), chamaephyte (41.66 %) and Nano-phanerophyte (8.33 %). All of the studied species are mono-regional elements belonging to the Saharo-Sindian chorotype. The field observation revealed that some of the endemic species confined to Saint Katherine Protectorate (SKP) are characterized by low seed fitting and low seedling's survival rate and these are the factors that lead to the disappearance of these species from their natural habitats of SKP and are included among the threatened species list of SKP.*

***Keywords:*** *Endemic plant species - Saint Katherine Protectorate, Sinai, Egypt .*

## INTRODUCTION

Loss of biodiversity has become an issue of great global concern and the identification of species status had been recognized as an urgent task. Egypt is among the hot arid regions of the world, where only little attention has been given to its threatened plant species (Amer, 2004). These species represent important elements in the Egyptian genetic, heritage, food, and medicinal potentialities (Carl-

quist, 1974; Strid, 1986 and Shehata & Kamel, 2007). Most of the endemic plants are treated as: very rare, endangered and severely threatened affected by several natural and human factors. The most important natural threats are the fragmentation inherent to its habitat and the aridity of the area, with very scarce precipitation year round. Human impacts, especially water collection for human consumption, sheep and goat grazing, and traditional plant collection for medicinal uses, further intensify the natural threats of aridification and fragmentation, thus pushing these species to the brink of extinction (Zaghloul *et al.,* 2006 and Mansour *et al.,* 2013).

The number of endemic taxa in the Egyptian flora varied from author to author, it comprises 69 taxa according to Täckholm (1974), 53 taxa (El Hadidi & Fayed, 1994/95), 60 taxa (Boulos, 1995 & 2009), 62 taxa (El Hadidi & Hosni, 2000). Boulos (2009), tabulated 60 plant taxa endemic to Egyptian flora of which 31 taxa occur in Sinai Peninsula (i.e. 51.66% of the Egyptian endemic taxa). Twenty four taxa of them are endemic to Sinai and the rest (7 taxa) are endemic to Sinai and other mainland regions of Egypt. These endemics are grouped under 50 genera and 26 families out of the total, 2145 species, 755 genera and129 families of the Egyptian flora. The highest endemics are restricted to family Asteraceae (8 taxa), Fabaceae (7 taxa), Caryophyllaceae (6 taxa) and each of Brassicaceae, Lamiaceae, Scrophulariaceae and Hyacinthaceae is represented by 4 taxa. Studies of the endemic taxa in Sinai floristic regions showed a high degree of habitat specificity. In other words, Sinai Peninsula is characterized by high number of regional and local endemism. For example the highest concentration of endemics is in southern Sinai (Sinai proper) in the rugged high mountainous districts that support the highest peaks in Egypt (Zohary, 1973).

The information about endemic species in Egypt is little including the percentage of species loss, taxonomic diversity, genetic diversity, species exploitation, species threats, species potentialities, and biomass productivity. Investigation and management of the endemics in the SKP need more taxonomic, ecologic and molecular studies. Out of the 28 endemic taxa of Sinai Peninsula (Three endemic species: *Phagnalon nitidum* Fresen., *Plantago sinaica* (Barn.) Decne., and *Silene odontopetala* Fenzl var. *congesta* Boiss., were exit from endemic list of S. Sinai according to Ghaly, 2015; the revision revealed that these species were traced in other localities out of Sinai), 17 taxa were occurring in South Sinai namely: *Bufonia multiceps* Decne., *Silene leucophylla* Boiss., *Silene schimperiana* Boiss., *Euphorbia obovata* Decne., *Ballota kaiseri* Täckh., *Origanum syriacum* L. subsp. *sinaicum* (Boiss.) Greuter & Burdet, *Phlomis aurea* Decne., *Polygala sinaica* Botsch. var. *sinaica, Primula boveana* Decne. ex Duby, *Rosa arabica* Crép., *Anarrhinum pubescens* Fresen., *Hyoscyamus boveanus* (Dunal) Asch. & Schweinf., **Silene oreosinaica* Chowdhuri, **Pterocephalus arabicus* Boiss., **Micromeria serbaliana* Danin & Hedge, **Astragalus fresenii* Decne. and **Veronica kaiseri* Täckh. The first 12 taxa had been recorded during the present study while the last five species (with asterisks) had not been traced living and no specimens were seen in the Egyptian herbaria (Ghaly, 2015). The objectives of this study are: verification of

the location distribution of the 12 endemic species in SKP; introduction and providing proposals to protect the endemic taxa of Egypt against distinction.

## MATERIALS AND METHODS

### THE STUDY AREA

### 2.1. Location and Geomorphology

Sinai Peninsula is a triangular plateau, northeast Egypt with its apex in the south at Ras Mohammed, where the eastern coast of Suez Gulf meets the western coast of Aqaba Gulf (Lat. 27°45' N). Its base is in the north along the Mediterranean Sea extending for about 240 km between Port Said (west) to Rafah (east) (Lat. 31°12'N) with area about 61,000 $km^2$, comprises 6% of Egypt area. More than half of the peninsula is between the Gulfs of Aqaba and Suez (Zahran & Willis, 2009). The present study had been carried out in the southern part of Sinai specifically in Saint Katherine mountainous area which has been declared as protectorate area in 1996 by the Egyptian Environmental Affairs Agency (EEAA). It is an elevated triangular plateau with an approximate area of 4350 $km^2$. SKP is the fourth largest protectorate in Egypt located between 33° 55' to 34° 30' East, and 28° 30' to 28° 35' North with elevation range of 1300 to 2600 m (Moustafa & Klopatek, 1995 and Mosallam, 2007). The plateau is composed of igneous and metamorphic rocks with the highest peaks of Gebel Saint Katherine (2642 m), Gebel Um Shomer (2586 m), Gebel Mousa (2285 m) and the adjoining peaks (Said, 1962; Abd EL-Wahab *et al.,* 2006 and Mosallam, 2007).

The present study had been focused on the distribution of the endemic taxa growing in the wadis crossing Saint Katherine Mountains and their tributaries located between 28°31'16.19" to 28°34'56.17" North and 033°51'36.30"to 033°59'45.35" East. Thirty six wadis and farsh (=open areas) systems were surveyed as indicated in Table (1) and Figure (1).

**Table (1) :** Locations of the 36 surveyed wadis and farshs using GPS. (each is represented by one location only) in the Saint Katherine Protectorate.

| No. | Locations | | | Habitats |
|---|---|---|---|---|
| | Names | Longitude (N) | Latitude (E) | |
| 1 | Wadi El Arbain | 28°33'04.3560" | 033°56'59.3880" | wadi bed, slope, basin |
| 2 | Wadi Abu Heiman | 28°32'29.3600" | 033°56'50.7500" | gorge, slope |
| 3 | Kahf El Gholah | 28°32'44.5600" | 033°56'56.2600" | gorge |
| 4 | Wadi Shagg Musa | 28°31'40.0100" | 033°57'42.1600" | gorge, slope |
| 5 | Ein El Shenar | 28°31'23.9900" | 033°57'32.6200" | gorge, slope |
| 6 | Wadi Garginya | 28°31'45.2640" | 033°58'08.8680" | wadi bed, gorge, slope |
| 7 | Wadi El Dair | 28°33'28.0080" | 033°58'40.8000" | wadi bed, slope |
| 8 | Farsh Safsafa | 28°33'01.2960" | 033°58'30.4680" | basin |
| 9 | Wadi Sharig | 28°33'09.7920" | 033°57'13.5000" | wadi bed, slope |
| 10 | El Freish | 28°33'20.9880" | 033°57'56.0880" | basin |
| 11 | Gebel Ahmar | 28°31'44.0400" | 033°56'24.5400" | slope |
| 12 | Kiniset El Homar | 28°32'47.5080" | 033°57'58.1760" | basin |
| 13 | Ein Shkaya | 28°32'33.3240" | 033°55'56.6040" | basin, slope |
| 14 | Farsh Shoeib | 28°33'07.5960" | 033°58'00.1920" | basin |
| 15 | Gebel Abbas Basha | 28°33'34.9920" | 033°54'28.8000" | basin, slope |
| 16 | Wadi El Meserdy | 28°32'43.6560" | 033°56'17.6640" | wadi bed, slope |
| 17 | Islibet | 28°32'41.2080" | 033°56'02.1120" | basin |
| 18 | Wadi El Tallaa el kebeera | 28°33'14.4000" | 033°52'38.3880" | wadi bed, slope |
| 19 | Wadi Shagg | 28°32'27.7400" | 033°55'50.1600" | gorge, slope |
| 20 | Wadi Zuweitin | 28°32'21.3000" | 033°55'27.4800" | wadi bed, slope |
| 21 | Abu Gasaba (W. Gibal) | 28°31'46.0200" | 033°53'53.0880" | basin, slope |
| 22 | Abu-Walea'a (W. Gibal) | 28°32'03.8400" | 033°54'38.8440" | basin, slope |
| 23 | Rehebit Nada (W. Gibal) | 28°32'18.3120" | 033°54'42.8040" | basin |
| 24 | Wadi Ma'aroffiaa | 28°31'24.6000" | 033°53'16.6560" | wadi bed, slope |
| 25 | Farsh Rummana | 28°32'08.5200" | 033°53'03.6600" | wadi bed, gorge, slope, basin |
| 26 | Farsh Umm Sila | 28°34'19.8120" | 033°52'57.6840" | basin |
| 27 | Wadi Sagr | 28°34'37.2000" | 033°53'53.3400" | gorge, slope |
| 28 | Wadi Tinya | 28°34'11.3880" | 033°54'07.9200" | gorge, slope |
| 29 | Sad Abu Hbeig | 28°33'39.8880" | 033°52'21.2880" | gorge, slope |
| 30 | Wadi Abu Tuweita | 28°34'08.6880" | 033°53'53.3040" | gorge, slope |
| 31 | Wadi Talla | 28°33'42.3000" | 033°56'00.4920" | wadi bed, gorge, slope, basin |
| 32 | Wadi Itlah | 28°34'39.7920" | 033°55'34.5360" | wadi bed, basin, slope |
| 33 | Wadi El Tofaha | 28°32'59.4240" | 033°56'25.7640" | wadi bed, slope |
| 34 | Gebel Muneiga | 28°32'48.0120" | 33°59'04.9920" | wadi bed, slope |
| 35 | Farsh Loza | 28°32'55.2120" | 033°58'17.1840" | basin |
| 36 | Loger | 28°34'30.5040" | 033°58'51.4200" | basin |

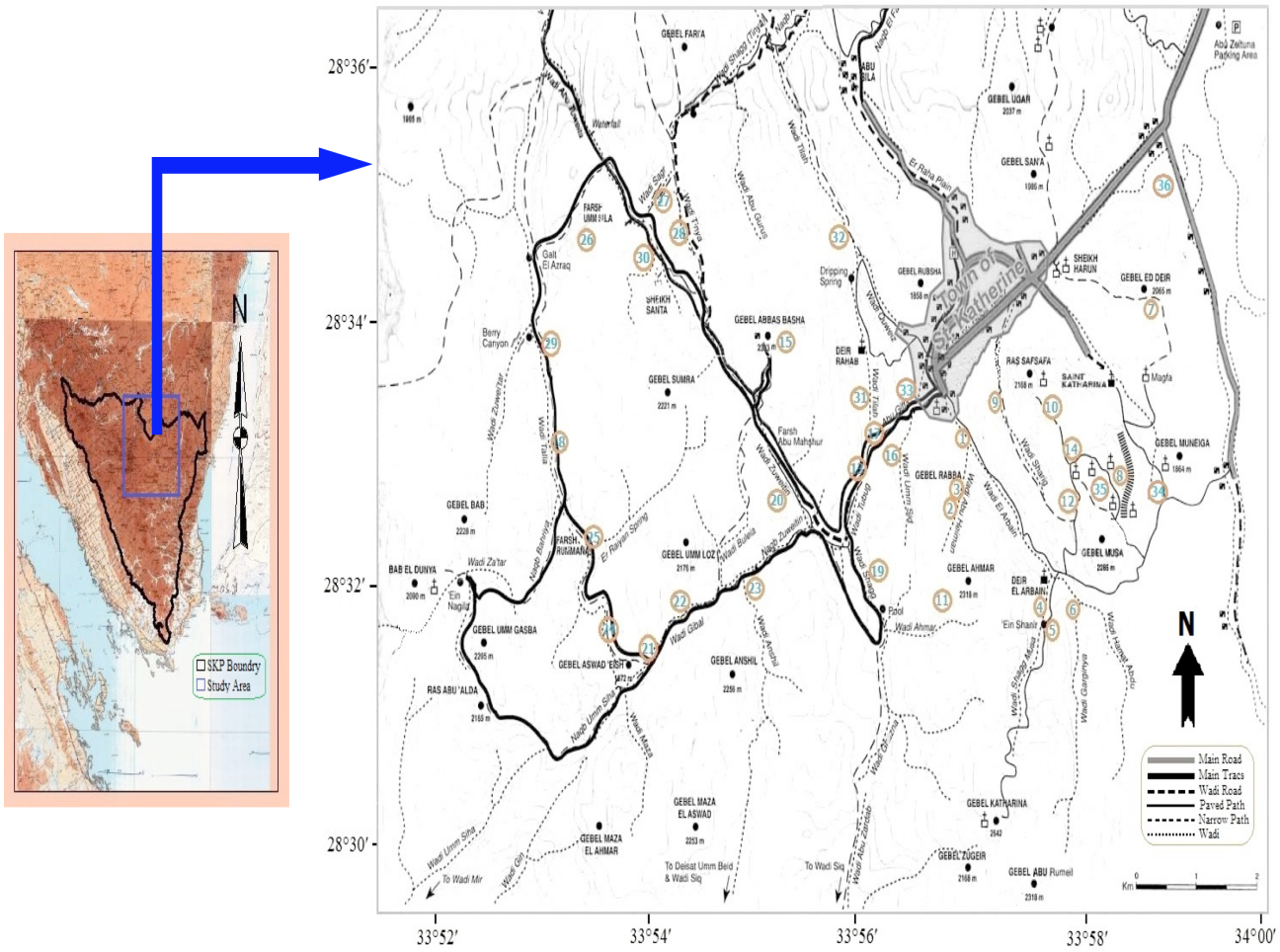


**Figure (1) :** Map showing the locations of the 12 studied endemic taxa in 36 surveyed wadis in Saint Katherine Protectorate

### 2.2. Climate

The climatic factors are the master of all environmental factors that control not only the plant growth but also, the development, distribution and densities of the vegetation on the earth (Zahran, 1989). According to Ayyad & Ghabbour (1986), Sinai Peninsula can be divided into two main climatic zones: arid and hyperarid. The arid zone includes the northern subregion: summer is hot, winter is mild and rainfall usually occurs in winter. The hyperarid zone covers the central and southern subregions of the peninsula. Moustafa & Klopatek (1995) mentioned that SKP is the coolest area in Sinai owing to its high elevation. The mean temperatures ranged from 5·4℃ to 25·1℃ with the lowest temperature in January and February and the highest temperature in July and August. At Gebel Katherina, mean monthly temperature ranges from –1℃ to 2℃ in winter and 17℃ to 19℃ in summer. Ayyad *et al.* (2000) stated that high mountains in the SKP receive higher amounts of precipitation (100 mm / year) as rain and snow. The low elevation sites are climatically characterized by very dry summers with 5-30 mm precipitation per year. On the other hand, the high elevation district of South Sinai receives 35-50 mm of precipitation per year (Moustafa & Zayed, 1996 and Abd EL-Wahab *et al.,* 2006).

During this study the retrieved climatic data (Table 2), including average air temperature "℃" wind velocity and rainfall "mm", obtained from SKP weather station during 2010-2012 indicating that summer months, July and August are the hottest months, while the coldest winter months are January and February. The mean average temperature ranged between 7.58℃ in January and 25.04℃ in August. Rainfall was irregular and scanty; the total mean amount of annual rainfall was 18.32 mm during the period from 2010 to 2012. Generally, most of the months are rainy where the highest monthly mean of rainfall is concentrated in February 6.70 mm, while the monthly mean minimum rainfall were zero mm in June, July, August, October and November. It is noticed that there is a wide variation in wind velocity throughout the whole year where it ranged from 3.26 Km/hour as mean minimum value in November to 8.26 Km/hour as mean maximum value in March.

### 2.3. Data collection and analysis

Ecologically, the different habitats of the studied taxa in SKP were determined during the first visit of the study area, these are: wadi bed, gorge, slope and basin or farsh. The presence values of the 12 studied endemic species were calculated according to Braun-Blanquet, (1964), chorology were cited according to Wickens (1976), Life forms (Therophytes, Geophytes, Hemicryptophytes, Chamaephytes and Phenrophytes) were identified according to Raunkiaer (1934) and Danin (1983). Location distributions of the studied species were determined in study area using GPS receiver “Trimble model”. Identification and nomenclature were conducting according to: Zohary (1966 & 1972); Täckholm (1974); Feinbrun (1978 & 1986); Boulos (1995, 1999, 2000, 2002, 2005 & 2009) and El Hadidi & Hosni (2000).

**Table (2) :** Mean monthly values of climatic factors of Saint Katherine Protectorate (SKP), during the study period (2010 – 2012), After SKP weather station: 2010-2012.

| Months | Average Air Temperature (°C) | Wind Velocity (Km / hour) | Total Rainfall (mm) |
|---|---|---|---|
| **January** | 7.58 | 6.08 | 2.30 |
| **February** | 9.98 | 7.66 | 6.70 |
| **March** | 13.42 | 8.26 | 5.50 |
| **April** | 17.60 | 7.64 | 1.80 |
| **May** | 20.40 | 6.80 | 0.46 |
| **June** | 23.70 | 6.22 | 0.00 |
| **July** | 24.14 | 4.82 | 0.00 |
| **August** | 25.04 | 5.42 | 0.00 |
| **September** | 22.34 | 5.80 | 0.16 |
| **October** | 18.70 | 5.35 | 0.00 |
| **November** | 13.14 | 3.26 | 0.00 |
| **December** | 11.22 | 4.40 | 1.40 |
| **Total annual rainfall** | | 18.32 | |

## RESULTS

### 1. Habitats and Altitudes:

Data in Table (3) and Figure (2) show that studied endemic taxa are growing in four types of habitats these are: wadi bed (including terraces), gorge, slope and basin (farsh). Gorge habitat represents the most suitable habitat for the growth of endemic species where it harbors ten of studied species representing 83.33 % followed by the slope habitat which harbors eight species representing 66.66% then wadi bed habitat, having seven species representing 58.33% and finally basin habitat which comprises six species representing 50%. All the studied taxa are growing in gorge habitat except two species namely: *Bufonia multiceps* and *Silene leucophylla*. Four species namely: *Silene schimperiana, Origanum syriacum subsp. sinaicum, Phlomis aurea* and *Anarrhinum pubescens* are inhabiting the four habitat types. Some endemic species are characterized by specific habitat as: *Silene leucophylla* was confined to slope habitat, *Ballota kaiseri* and Rosa arabica, both are restricted only to gorge habitat while *Polygala sinaica* var. *sinaica* and *Primula boveana* were specific to gorge and slope habitats. On the other hand *Bufonia multiceps* and *Euphorbia obovata* have been recorded in three types of habitat while *Hyoscyamus boveanus* grows in wadi bed and gorge habitats.

The altitudinal variations of the studied species were recorded in the 36 surveyed localities. Data outlined in Table (3) shows the maximum, minimum and mean values of altitudes. According to the mean values of elevations, the studied species could be classified under three categories these are: species growing at, relatively, high altitudes (above 2000 m) these are: *Silene leucophylla* and *Ballota kaiseri*; species growing at medium

altitudes (1750 - 1900 m) these are: *Phlomis aurea*, *Polygala sinaica* var. *sinaica, Primula boveana*, *Anarrhinum pubescens* and *Rosa arabica*; and species growing at, relatively, low altitudes (1600 -1750 m) these are: Bufonia multiceps, *Silene schimperiana, Euphorbia obovata, Origanum syriacum* subsp. *sinaicum* and *Hyoscyamus boveanus*.

**Table (3) :** Habitats and Altitudes of the studied endemic species. (W: Wadi Bed, G: Gorge, S: Slope and B: Basin).

| No. | Species | Habitats | | | | Altitude (m a. s. l) | | |
|---|---|---|---|---|---|---|---|---|
| | | W | G | S | B | Min. | Max. | Mean |
| 1 | *Bufonia multiceps* | + | - | + | + | 1525 | 1928 | 1726 |
| 2 | *Silene leucophylla* | - | - | + | - | 2100 | 2100 | 2100 |
| 3 | *Silene schimperiana* | + | + | + | + | 1466 | 2011 | 1738 |
| 4 | *Euphorbia obovata* | + | + | - | + | 1448 | 2028 | 1738 |
| 5 | *Ballota kaiseri* | - | + | - | - | 2020 | 2020 | 2020 |
| 6 | *Origanum syriacum* subsp. *sinaicum* | + | + | + | + | 1483 | 1990 | 1737 |
| 7 | *Phlomis aurea* | + | + | + | + | 1383 | 2140 | 1761 |
| 8 | *Polygala sinaica* var. *sinaica* | - | + | + | - | 1505 | 2111 | 1808 |
| 9 | *Primula boveana* | - | + | + | - | 1655 | 2052 | 1853 |
| 10 | *Rosa arabica* | - | + | - | - | 1750 | 1932 | 1841 |
| 11 | *Anarrhinum pubescens* | + | + | + | + | 1500 | 2000 | 1750 |
| 12 | *Hyoscyamus boveanus* | + | + | - | - | 1385 | 1835 | 1610 |

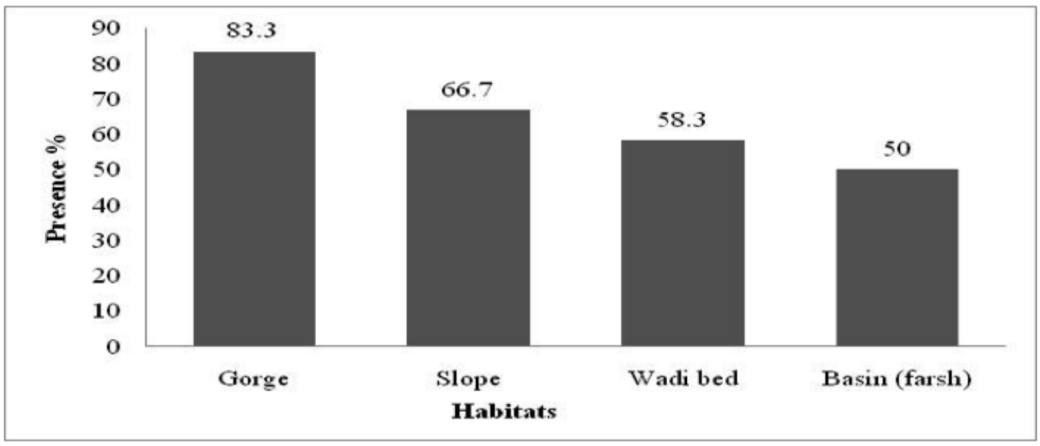


**Figure (2) :** Presence value of plant species in the different habitats types.

**2. Geographical Distribution:**

The distribution of the studied endemic taxa in the 36 surveyed different locations in SKP is shown in (Table 4 and Figure 3). It is obvious that there is a wide variation in the occurrence of the studied taxa in these locations. Phlomis aurea has the highest presence value, (97.2%) as it occurs in almost all surveyed locations except Kahf El Gholah, while *Origanum syriacum, Anarrhinum pubescens, Bufonia multiceps* and *Polygala sinaica* have presence values of 69.4%, 66.6%, 58.3% and 55.5%, respectively. On the other hand *Euphorbia obovata, Silene schimperiana* and *Hyoscyamus boveanus*, have presence values of 44.4%, 41.6% and 25%, respectively. *Silene leucophylla, Ballota kaiseri, Primula boveana* and *Rosa arabica* are the rarest wild endemic species with the lowest presence values (2.7, 2.7, 13.8 and 22.2%) respectively. These taxa are growing in restricted localities, the first two species were recorded in one location namely: Ein El Shenar and Wadi Abu Heiman; respectively. On the other hand, *Primula boveana* was restricted only to five localities namely: Kahf El Gholah, Wadi Shagg Musa, Ein El Shenar, Wadi Garginya and Sad Abu Hbeig, while *Rosa arabica* was traced in eight locations namely: Wadi El Arbain, Kahf El Gholah, Wadi Shagg Musa, Gebel Ahmar, Farsh Rummana, Wadi Sagr, Wadi Tinya and Wadi Abu Tuweita.

Table (4) clarified that Farsh Rummana contains the highest number of endemic taxa, (9 taxa) representing (75 %) from the studied taxa, followed by Wadi Talla and Wadi Tinya which contain 8 taxa, each representing (66.66%). Each of Wadi El Arbain, Gebel Ahmar and Wadi El Meserdy contains 7 taxa representing (58.33%) each, while Wadi Abu Heiman, Kahf El Gholah, Wadi Shagg Musa, Wadi Sharig, El Freish, Wadi Shagg, Abu-Walea'a and Wadi Itlah contains 6 taxa for each representing (50%) of the studied taxa. On the other hand, each of Ein El Shenar, Wadi Garginya, Islibet, Wadi El Tallaa Kebeera, Wadi Zuweitin, Wadi Abu Tuweita, Wadi El Tofaha, Farsh Loza and Ein Shkaya contains 5 taxa representing (41.66%). Six locations namely: Farsh Shoeib, Gebel Abbas Basha, Abu Gasaba, Rehebit Nada, Farsh Umm Sila and Wadi Sagr containing 4 taxa for each representing (33.33%) of the studied taxa, while three locations namely: Wadi El Dair, Wadi Ma'aroffiaa and Gebel Muneiga each contains 3 taxa representing (25%) of the studied taxa. The lowest number of endemic (2 taxa) occurs in four locations namely: Farsh Safsafa, Kiniset El Homar, Sad Abu Hbeig and Loger representing (16.66%) of the studied taxa.

**Table (4) :** Distribution of the 12 studied endemic taxa in the different locations of Saint Katherine Protectorate.

| No. | Locations | Studied Endemic Species | | | | | | | | | | | | Total number of endemic taxa in each location |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | *Bufonia multiceps* | *Silene leucophylla* | *Silene schimperiana* | *Euphorbia obovata* | *Ballota kaiseri* | *Origanum syriacum* | *Phlomis aurea* | *Polygala sinaica* | *Primula boveana* | *Rosa arabica* | *Anarrhinum pubescens* | *Hyoscyamus boveanus* | |
| 1 | Farsh Rummana | + | – | + | + | – | + | + | + | – | + | + | + | 9 |
| 2 | Wadi Talla | + | – | + | + | – | + | + | + | – | – | + | + | 8 |
| 3 | Wadi Tinya | + | – | + | + | – | – | + | + | – | + | + | + | 8 |
| 4 | Wadi El Arbain | + | – | – | – | – | + | + | + | – | + | + | + | 7 |
| 5 | Gebel Ahmar | + | – | + | + | – | + | + | – | – | + | + | – | 7 |
| 6 | Wadi El Meserdy | + | – | + | + | – | + | + | – | – | – | + | + | 7 |
| 7 | Wadi Abu Heiman | + | – | + | – | + | + | + | – | – | – | + | – | 6 |
| 8 | Kahf El Gholah | – | – | + | – | – | + | – | + | + | + | + | – | 6 |
| 9 | Wadi Shagg Musa | – | – | + | – | – | + | + | + | + | + | – | – | 6 |
| 10 | Wadi Sharig | + | – | + | – | – | + | + | + | – | – | + | – | 6 |
| 11 | El Freish | + | – | + | – | – | + | + | + | – | – | + | – | 6 |
| 12 | Wadi Shagg | – | – | + | + | – | + | + | + | – | – | + | – | 6 |
| 13 | Abu-Walea'a (W.Gibal) | + | – | – | + | – | + | + | + | – | – | + | – | 6 |
| 14 | Wadi Itlah | + | – | – | + | – | + | + | – | – | – | + | + | 6 |
| 15 | Ein El Shenar | – | + | – | – | – | + | + | + | + | – | – | – | 5 |
| 16 | Wadi Garginya | – | – | + | – | – | – | + | + | + | – | + | – | 5 |
| 17 | Islibet | – | – | + | + | – | + | + | – | – | – | + | – | 5 |
| 18 | Wadi El Tallaa Kebeera | – | – | + | + | – | + | + | + | – | – | – | – | 5 |
| 19 | Wadi Zuweitin | + | – | – | + | – | + | + | + | – | – | – | – | 5 |
| 20 | Wadi Abu Tuweita | + | – | – | – | – | – | + | + | – | + | + | – | 5 |
| 21 | Wadi El Tofaha | + | – | – | – | – | + | + | – | – | – | + | + | 5 |
| 22 | Farsh Loza | + | – | – | – | – | + | + | – | – | – | + | + | 5 |
| 23 | Ein Shkaya | – | – | – | + | – | + | + | + | – | – | + | – | 5 |
| 24 | Farsh Shoeib | + | – | – | – | – | + | + | – | – | – | + | – | 4 |
| 25 | Gebel Abbas Basha | – | – | – | + | – | + | + | – | – | – | – | + | 4 |
| 26 | Abu Gasaba (W.Gibal) | – | – | – | + | – | – | + | + | – | – | + | – | 4 |
| 27 | Rehebit Nada (W.Gibal) | + | – | – | + | – | – | + | – | – | – | + | – | 4 |
| 28 | Farsh Umm Sila | + | – | + | – | – | – | + | – | – | – | + | – | 4 |
| 29 | Wadi Sagr | – | – | – | – | – | – | + | + | – | + | + | – | 4 |
| 30 | Wadi El Dair | + | – | – | – | – | + | + | – | – | – | – | – | 3 |
| 31 | Wadi Ma'aroffiaa | + | – | – | – | – | – | + | + | – | – | – | – | 3 |
| 32 | Gebel Muneiga | + | – | – | – | – | + | + | – | – | – | – | – | 3 |
| 33 | Farsh Safsafa | – | – | – | – | – | – | + | + | – | – | – | – | 2 |
| 34 | Kiniset El Homar | – | – | – | + | – | – | + | – | – | – | – | – | 2 |
| 35 | Sad Abu Hbeig | – | – | – | – | – | – | + | – | + | – | – | – | 2 |
| 36 | Loger | – | – | – | – | – | + | + | – | – | – | – | – | 2 |
| Numbers of taxon in the locations | | 21 | 1 | 15 | 16 | 1 | 25 | 35 | 20 | 5 | 8 | 24 | 9 | |
| Presence percentage (P %) of the endemic taxa | | 58.3 | 2.7 | 41.6 | 44.4 | 2.7 | 69.4 | 97.2 | 55.5 | 13.8 | 22.2 | 66.6 | 25 | |

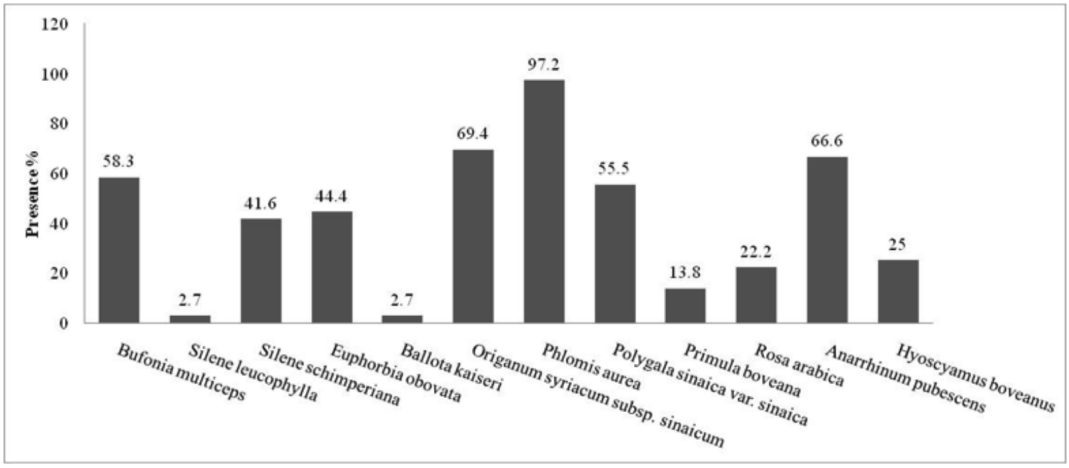


**Figure (3) :** Presence value of plant species in the studied wadis.

### 3. Life form

Data outlined in Table (5) and Figure (4) indicated that, studied species are belonging to eight families namely: Caryophyllaceae (3 taxa), Lamiaceae (3 taxa) and each of Euphorbiaceae, Polygalaceae, Primulaceae, Scrophulariaceae, Rosaceae and Solanaceae represented by one species. Three different life forms were recorded, these are hemicryptophyte (50%) was the dominant life form comprises six species namely: *Bufonia multiceps*, *Silene leucophylla, Silene schimperiana, Euphorbia obovata, Primula boveana* and *Anarrhinum pubescens*. On the other hand chamaephyte (41.66 %) includes five species: *Ballota kaiseri, Origanum syriacum* subsp. *sinaicum, Phlomis aurea, Polygala sinaica* var. *sinaica* and *Hyoscyamus boveanus*, while Nano-phanerophyte (8.33 %) is represented by one species Rosa arabica.

### 4. Chorology

Data in Table (5) indicates that, all of the studied species are mono-regional elements belonging to the Saharo-Sindian chorotype. Eleven of these species are endemic and confined to SKP while one species namely: Hyoscyamus boveanus is endemic to Egypt.

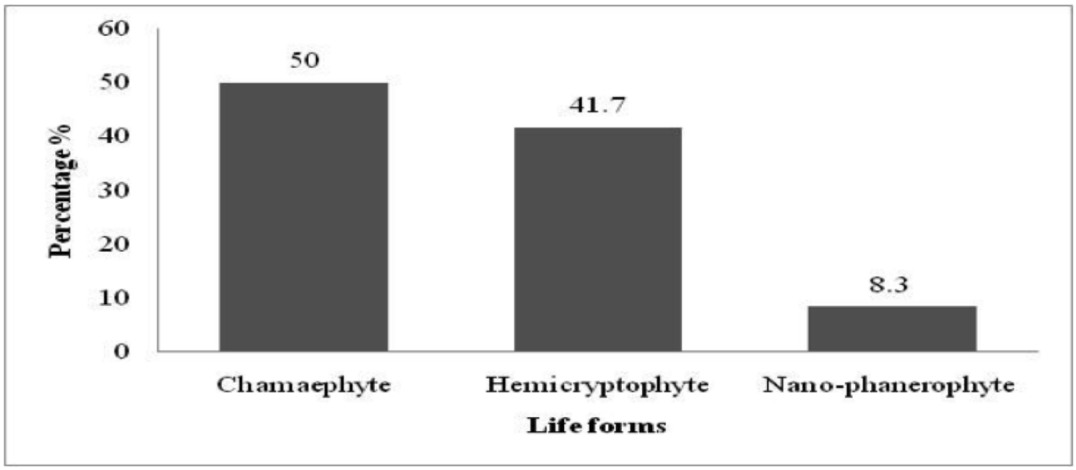


**Figure (4) :** Percentage of life form of plant species in the studied wadis.

**Table (5) :** Habitats and Altitudes of the studied endemic species. (W: Wadi Bed, G: Gorge, S: Slope and B: Basin).

| No | Species | Family | Life form | Chorology |
|---|---|---|---|---|
| 1 | *Bufonia multiceps* | Caryophyllaceae | Hemicryptophyte | Endemic to SKP belongs to Saharo-Sindian region |
| 2 | *Silene leucophylla* | Caryophyllaceae | Hemicryptophyte | Endemic to SKP belongs to Saharo-Sindian region |
| 3 | *Silene schimperiana* | Caryophyllaceae | Hemicryptophyte | Endemic to SKP belongs to Saharo-Sindian region |
| 4 | *Euphorbia obovata* | Euphorbiaceae | Hemicryptophyte | Endemic to SKP belongs to Saharo-Sindian region |
| 5 | *Ballota kaiseri* | Lamiaceae | Chamaephyte | Endemic to SKP belongs to Saharo-Sindian region |
| 6 | *Origanum syriacum* subsp. *sinaicum* | Lamiaceae | Chamaephyte | Endemic to SKP belongs to Saharo-Sindian region |
| 7 | *Phlomis aurea* | Lamiaceae | Chamaephyte | Endemic to SKP belongs to Saharo-Sindian region |
| 8 | *Polygala sinaica* var. *sinaica* | Polygalaceae | Chamaephyte | Endemic to SKP belongs to Saharo-Sindian region |
| 9 | *Primula boveana* | Primulaceae | Hemicryptophyte | Endemic to SKP belongs to Saharo-Sindian region |
| 10 | *Rosa arabica* | Rosaceae | Nano-phanerophyte | Endemic to SKP belongs to Saharo-Sindian region |
| 11 | *Anarrhinum pubescens* | Scrophulariaceae | Hemicryptophyte | Endemic to SKP belongs to Saharo-Sindian region |
| 12 | *Hyoscyamus boveanus* | Solanaceae | Chamaephyte | Endemic to Egypt belongs to Saharo-Sindian region |

## DISCUSSION

Biological diversity, or biodiversity, refers to the variety of distinct ecosystems or habitats, the number and variety of species within them, and the range of genetic diversity within the populations of these species. Two attributes of biodiversity have attracted particular attention from the international conservation community: species richness (the number of species in an area), and endemism (the number of species in that area that occur nowhere else) (Caldecott *et al.,* 1996 and Ayyad *et al.,* 2000). The plant life of the Sinai Peninsula has been a subject of interest which attracted many botanists and explorers (Batanouny, 1985 and Boulos, 2008). The Sinai Peninsula, which occupies an area of 61,000 $km^2$ or 6.1% of the total area of Egypt, is rich both in the number of species and the high percentage of endemics. Gaston (1994) define endemism as the restriction of the natural range of a taxon to a defined geographical distribution; taxa with narrow distributed range are Steno-endemics. Sinai endemics are characterized by a high level of regional and local endemism. The highest concentration of endemics is in southern Sinai (Sinai proper) in the rugged mountainous districts that support the highest peaks in Egypt (El Hadidi, 1967; Zohary, 1973; Wickens, 1977; Boulos, 1997 and Abd El-Ghani & Amer, 2003). Saint Katherine Mountains are a

centre of endemism (Zohary, 1973 and Shmida, 1984).

There are six habitats in SKP each has its own specific environmental conditions, landscapes and flora rich in medicinal, rare and endemic taxa. These habitats are: 1- Wadi Beds, 2- Terraces, 3- Slopes, 4- Gorges, 5- Basins (i.e. farsh) and 6- Caves (Khedr, 2007). However, the 12 studied endemic taxa are growing in four types of habitats these are: wadi bed (including terraces), gorge, slope and basin (farsh). Gorge habitat is the richest (10 taxa from 12 studied taxa) followed by slope (8 taxa), wadi bed (7 taxa) and basins (6 taxa). Gorges are characterized by filling materials, sediments and a highest proportion of gravel and fine grains between the boulders of soil pockets which accumulate high quantity of water. In addition, some gorges originate from dikes that trap water. This may be related to the specific needs of many endemic and rare species to special habitats (Raven, 1964; Cowling *et al.,* 1992; Linder *et al.,* 1993; Trinder-Smith *et al.,* 1996 and Ayyad *et al.,* 2000). The slope habitat, especially the slope that resulted from gullies on the tops of mountains or the slopes of depressions, has high species richness and is favourable for the growth of subshrubs and annual species. Terraces comprise platforms of bedrock mantled whether mantled with a sheet of gravel and sand or rocky surface which lead to decrease individual numbers along terraces. Terraces with rocky surfaces support poor species richness; this is due to the shallow soil cover that is inadequate to support plant growth. These results agree with the previous works carried out by Danin *et al.* (1985); Moustafa & Klopatek (1995); Ayyad *et al.* (2000); Abd EL-Wahab et al. (2006); Mosallam (2007); Danin (2008) and Al-Fiky *et al.* (2012). All these studies confirmed that the endemic taxa in Sinai showed a high degree of habitat specificity.

Topography and soil type are the principal controlling factors in vegetation growth (Wood *et al.,* 1988 and Dawes & Short, 1994), associated with local climate (Davies *et al.,* 2007), elevation, aspect and slope (Titshall *et al.,* 2000). Elevation along with aspect and slope determines the microclimate and thus large-scale spatial distribution and patterns of vegetation (Allen & Peet, 1990 and Busing *et al.,* 1992). Moustafa (1990), in his study in SKP reported that the community organization type is the net result of the behavior of the species in response to the environmental conditions that prevail in each particular habitat. However, in this investigation, all studied endemic taxa were growing in wide range of elevations, the average altitude ranged from 1610 to 2100 m asl supported the growth of 12 studied endemic species. This results were supported by the previous work carried out by Danin *et al.* (1985) who founded that many endemic taxa such as: *Buffonia multiceps, Ballota kaiseri, Phlomis aurea, Anarrhinum pubescens, Silene schimperiana, Euphorbia obovata* and *Polygala sinaica* occur in both lower and higher Sinai massif, while Silene *leucophylla, Primula boveana* and *Rosa arabica* are restricted only to the higher Sinai massif with 1500-2642 m altitude. Also habitats of high elevation have special species like *Primula boveana* (1655-2052 m asl) and *Silene leucophylla* (2100 m asl). Some species like *Phlomis aurea* are distributed in wide altitudinal gradient (1383-2140 m asl). The wide alti-

tudinal variation in south Sinai is related to its effect on temperature and moisture availability (Peet, 1988). Among three topographic factors, elevation is the most important, this conclusion was supported earlier by Busing *et al.* (1992).

The low elevation sites are climatically characterized by very dry summers with 5 - 30 mm precipitation per year. These low elevations have some special species like *Hyoscyamus boveanus*. On the other hand, the high elevation district of South Sinai receives 35 - 50 mm of precipitation per year (Shabana, 2013). Zohary (1973) and Moustafa & Zayed (1996) concluded that moisture, in the form of rainfall, is the most decisive factor controlling productivity, plant distribution, and life form in arid lands. Danin (2008) stated that elevation of the magmatic metamorphic massive of south Sinai is much higher and there are hard limestone, dolomite, sandstone, and granite which constitute, under certain conditions, smooth-faced outcrops such as Gebel Serbal and Gebel Musa. This habitat supports the most rare plant species in the desert including most of the desert endemics of Israel, Sinai, and Jordan. The concentration of the endemic species in the SKP could be due to its peculiar physiographic and climatic conditions, forming specific microhabitats, each with peculiar environmental conditions, to prevail the growth of the studied endemic species. These physiographic and climatic barriers have provided excellent ecological refugia and contributed to restriction of many endemic taxa (Mosallam, 2007).

The present study revealed that, some endemic taxa with high presence values (97.2%) as *Phlomis aurea* (occurs in almost all surveyed locations except Kahf El Gholah) produce seeds which respond easily to germination in high percentage at most conditions and habitats, these species also have high survival of seedlings, high seed production and can tolerate drought (field observation). On the other hand, taxa with low presence values in the study area have difficult in seed germination, so they need specific treatments, for example *Rosa arabica* (presence value, 22.2%) needs long germination period. Polygala sinaica (presence value, 55.5 %) also have low survival of seedling and high mortality of seedlings, through their juvenile stage and low seed production. These results were confirmed by workers in Medicinal Plants Conservation Project (2012). *Primula boveana* (presence value, 13.8 %) are restricted to moisture habitats near small springs which flow throughout the year on red granite as they cannot tolerant drought. It produces millions of dust seeds, most of them fail to germinate until it land in the appropriate moist habitat (Danin, 1983). The rarity of some species in SKP as *Silene lecophylla, Ballota kaiseri* (presence values 2.7% and 2.7) may be due to slow regeneration and climatic aridity. The causes of mortality in shrub seedlings, through the early months of life are attributed to drought (Shaltout & Ayyad, 1988; Mosallam, 2007 and Shabana, 2013). The field observation during this work revealed that some of the endemic species confined to SKP (*as Silene oreosinaica, Silene leucophylla, Ballota kaiseri, Rosa arabica, Pterocephalus arabicus, Micromeria serbaliana, Astragalus fresenii and Veronica kaiseri*) are characterized by low seed fitting and the low seedling's survival rate and these are among factors which lead

to the disappearance of these species from the natural habitats of SKP and to be included among the threatened species list of SKP. This conclusion was supported earlier by several authors (El-Demerdash, 2007; El-Mawey, 2008 and Saker *et al.,* 2011). Also environmental factors, climatic factors, over collecting for scientific research, grazing and human impacts pushing these species to the brink of extinction or disappearance from their natural habitats.

The life form patterns of desert plants are reflected by the rainfall, topography and land form types (Kassas & Girgis, 1965 and Zohary, 1973). The recorded endemic species are belonging to three different life forms: hemicryptophyte (50%), chamaephyte (41.66 %) and Nano-phanerophyte (8.33 %). These results are in agreed with (Ayaad & El- Kady 1982; Shaltout *et al.,* 1996 and El Bana *et al.,* 2002) who stated that shrubs and undershrubs are the major components of arid and semi arid rangelands throughout Egypt and the world. Mosallam (2007) recorded that chamaephytes are the most frequent (76.6%) life form, followed by therophytes (10.6) and phanerophytes (8.5%) in Saint Katherine protectorate.

Eig (1931-1932) identified four phytogeographical regions in the Sinai Peninsula: the Mediterranean region, the Saharo-Sindian, the Irano-Turanian and the Sudano-Deccanian which was basically adopted by most workers for several decades. Täckholm (1974) recognized three phytogeographical regions in Sinai: the Mediterranean coastal region, the Isthmic desert (El-Tih and the region north of Wadi Tumilat) and Sinai proper (the mountainous plateau south of El-Tih). However, according to White (1993), the Sinai Peninsula totally lies within the Sahara regional transition zone. Boulos (1995) treats the entire Sinai Peninsula, including the coastal Mediterranean strip and El-Tih Desert east of Suez Canal, as one unit named Sinai "S" (Boulos, 2008). All of the studied species are mono-regional elements belonging to the Saharo-Sindian chorotype. Eleven of these species are endemic and confined to SKP while one species namely: Hyoscyamus boveanus is endemic to Egypt. However, previous studies by Danin (1986); Moustafa (1986 & 1990); Moustafa & Klopatek (1995); Ayyad *et al.* (2000); Mosallam (2007) and Al-Fiky *et al.* (2012) mentioned that mountains in south Sinai are characterized by Irano-Turanian elements as *Bufonia multiceps, Silene leucophylla, Ballota kaiseri, Phlomis aurea, Primula boveana, Rosa arabica and Anarrhinum pubescens, this now is not valid based on endemism* and the distribution map according to Wickens (1976), Sinai lies in Saharo-Sindian region.

## CONCLUSIONS

Field observations revealed that most of endemic taxa in SKP are characterized by habitat specificity, inappropriate population size, low seed fitting and low seedling's survival rate. These are among factors which lead to the disappearance of these species from the different habitats of SKP and to be included among the threatened species list. Also environmental factors including, climatic factors, over collection for scientific research, grazing and medicinal purposes are the cause of disappearance of these species from its natural habitats specially, they are habitat specific.

More studies are essentially needed to explain physiological drought phenomena in *Rosa arabica* and low seed fitting and low seedling's survival rate of most endemic taxa.

A proposal aiming at controlling the continuous destruction of the endemic plant species in SKP by *In situ* and *Ex Situ* conservation and rehabilitation of these plants is a must. Also management the collection of these plants for the purposes of; scientific research; folk medicine; grazing as well as eco-tourism, which lead to the extinction of the genetic resources of these plants, is essentially needed.

Apart from the studied endemic species of SKP, both Silene leucophylla Boiss., and Ballota kaiseri Täckh., populations could be included within the proposed wildlife sanctuary at Wadi Shagg Musa and Wadi Abu Heiman respectively, to be protected from extinction.

## REFERENCES

**Abd El-Ghani, M. M. and Amer, W. M. (2003):** Soil-vegetation relationships in a coastal desert plain of southern Sinai, Egypt. Journal of Arid Environments; 55: 607– 628.

**Abd EL-Wahab, R. H.; Zayed, A. M.; Moustafa, A. A.; Klopatek, J. M. and Helmy, M. A. (2006):** Landforms, vegetation, and soil quality in south Sinai, Egypt. Catrina; 1(2): 127–138.

**Al-Fiky, F. A.; Abo-El Khier, Z. A.; Marie, A. H. and Abd El Raof, D. (2012):** An ecological study of the distribution of *Origanum syriacum* L. within the plant communities in Saint Catherine, South Sinai. Journal of Jazan University, Applied Sciences Branch; 1 (2): 47– 59.

**Allen, R. B. and Peet, R. K. (1990):** Gradient analysis of forests of the Sangre de Cristo Range, Colorado. Canadian Journal of Botany; 68: 193–201.

**Amer, W. M. (2004):** Distribution of *Hyoscyamus* species in Egypt and their genetic relationships. Egyptian J. Desert Res.; 54 (1):1–13.

**Ayyad, M. A. and El- Kady, H. F. (1982):** Effect of protection and controlled grazing on the vegetation of a Mediterranean desert ecosystem in northern Egypt. Vegetatio; 49:129–139.

**Ayyad, M. A. and Ghabbour, S. I. (1986):** Hot deserts of Egypt and the Sudan. Chapter 5, 149-202, In: Evenari, M. *et al.* (eds), Hot Deserts and Arid Shrublands. Ecosystems of the World Series, Elsevier, Amsterdam, 451pp.

**Ayyad, M. A.; Fakhry, A. M. and Moustafa, A. A. (2000):** Plant biodiversity in the Saint Catherine area of the Sinai Peninsula, Egypt. Biodiversity and Conservation; 9: 265–281.

**Batanouny, K. H. (1985):** Botanical exploration of Sinai. Qatar University Science Bulletin; 5: 187–211.

**Boulos, L., (1995):** Flora of Egypt. Checklist. Al Hadara Publishing, Cairo, Egypt, 283p.

**Boulos, L. (1997):** Endemic flora of the

Middle East and North Africa. Pp 229–260, In: Barakat, H. N., Hegazy, A. K. (Eds.), Reviews in Ecology: Desert Conservation and Development. Metropole, Al-Hadara Publishing, Cairo, 331p.

**Boulos, L. (1999):** Flora of Egypt. Vol. 1. Azollaceae - Oxalidaceae. Al-Hadara Publishing, Cairo, Egypt, 419p.

**Boulos, L. (2000):** Flora of Egypt. Vol. 2. Geraniaceae- Boraginaceae. Al-Hadara Publishing, Cairo, Egypt, 392p.

**Boulos, L. (2002):** Flora of Egypt. Vol. 3. Verbenaceae – Compositae. Al-Hadara Publishing, Cairo, Egypt, 373p.

**Boulos, L. (2005):** Flora of Egypt, Vol. 4. Al-Hadara Publishing, Cairo, Egypt, 617p.

**Boulos, L. (2008):** Flora and vegetation of the deserts of Egypt. Flora Mediterranea; 18: 341–359.

**Boulos, L. (2009):** Flora of Egypt. Checklist. Al Hadara Publishing, Cairo, Egypt.410p.

**Braun-Blanquet, J. (1964):** Plant Sociology. MC, Braw-Hills Book, New York. 487 Pp.

**Busing, R. T.; White, P. S. and MacKende, M. D. (1992):** Gradient analysis of old spruce-fir forest of the great smokey mountains circa 1935. Canadian Journal of Botany; 71: 951–958.

**Caldecott, J.O.; Jenkins, M. D.; Johnson, T. H. and Groombridge, B. (1996):** Priorities for conserving global species richness and endemism. Biodiversity and Conservation; 5: 699–727.

**Carlquist, S. (1974):** Island Biology. Columbia Univ. Press, New York.

**Cowling, R. M.; Holmes, P. and Rebelo, A. G. (1992):** Plant diversity and endemism. Pp 62–110, In: Cowling R. M. (ed), The Ecology of Fynbos: Nutrients, Fire and Diversity. Oxford University Press, Cape Town.

**Danin, A. (1983):** Desert Vegetation of Israel and Sinai. Jerusalem, Cana Publishing House, 148p.

**Danin, A. (1986):** Flora and vegetation of Sinai. Proceedings of the Royal Society of Edinburgh; 89B: 159–168.

**Danin, A. (2008):** Desert Rocks. A habitat which supports many species that were new to science in the last 40 years. Turkish Journal of Botany; 32: 459–464.

**Danin, A.; Schmida, A. and Liston, A. (1985):** Contribution to the flora of Sinai. III. Check list of the species collected and recorded by the Jerusalem team (1967-1982). Willdenowia; 15: 255–322.

**Davis, K. W.; Bates, J. D. and Miller, R. F. (2007):** Environmental and vegetation relationships of the *Artemisia tridentate* spp. *Wyomingensis* alliance. J. Arid Environ.; 70: 478– 494.

**Dawes, W. R. and Short, D. (1994):** The significance of topology for modelling the surface hydrology of fluvial landscapes. Water

Resources Research; 30: 1045–1055.

**Eig, A. (1931-1932):** Les éléments et les groupes phytogéographiques auxiliares dans la flore palestinienne. Beih. Repert. Spec. Nov. Regni. Veg. 63 (1, texte): 1–201 (1931) & (2, Tabl. analyt.), 1–120 (1932).

**El-Bana, M. I.; Nijs, I. and Khedr, A. A. (2002):** Response of shrubs and undershrubs to protection against grazing in two islands of Lake Bardawil, Med. Coast of Egypt. Egyptian J. Desert Res.; 52(2): 235–250.

**El Hadidi, M. N. (1967):** Observations on the flora of Sinai mountain region. Bulletin de la Société de Geographie d' Egypte; 40: 123–155.

**El Hadidi, M. N. and Fayed, A. (1994/95):** Materials for Excursion Flora of Egypt (EFE). Taeckholmia; 15:1–233.

**El Hadidi, M. N. and Hosni, H. A. (2000):** Flora Aegyptiaca. Vol. 1, Part 1. Cairo University Herbarium. The Palm Press, Cairo, 187p.

**El-Demerdash, M. (2007):** The *Ex Situ* Conservation Technical Report on Propagation of Medicinal Plants, MPCP, The Egyptian Environmental Affairs Agency (EEAA), 71p.

**El-Mawey, M. (2008):** Technical report on restoration of endangered plant species in St. Catherine Protectorate. MPCP, Egyptian Environmental Affairs Agency (EEAA), 31p.

**Feinbrun-Dothan, N. (1978):** Flora Palestina, vol. III. Jerusalem: The Israel Academy of Sciences and Humanities.

**Feinbrun- Dothan, N. (1986):** Flora Palaestina. Vol. IV. The Israel Academy of Sciences and humanities. Jerusalem. 462p.

**Gaston, K. J. (1994):** Rarity. Chapman & Hall, London.

**Ghaly, O. N. (2015):** Taxonomical and Molecular Characterization on Endemic Species at Saint Katherine Protectorate- Sinai- Egypt. PhD. Botany Department, Faculty of Science, Mansoura University, Mansoura, Egypt. 129p. (in press).

**Kassas, M. and Girgis, W. A. (1965):** Habitats and plant communities in Egyptian desert. VI- The units of desert ecosystem. Journal of Ecology, 53: 715– 728.

**Kheder, A. (2007):** Assessment, classification, and analysis of microhabitats supporting globally significant plant species: Saint Katherine Protectorate, conservation and sustainable use of medicinal plants in arid and semi-arid eco-systems project, Egypt, Final Report (GEF & UNDP) (Project No: 12347/12348), 1-37.

**Linder, H. P.; Vlok, J. H.; McDonald, J. D.; Oliver, E. G. H.; Boucher, C.; Van Wyk, B. E. and Schutte, A. (1993):** The high altitude flora and vegetation of the Cape Floristic Region, South Africa. Opera Botanica; 121: 247–261.

**Mansour, H.; Jiménez, A.; Keller, B.; Nowak, M. D. and Conti, E. (2013):** Development of 13 Microsatellite Markers in the en-

dangered Sinai Primrose (*Primula boveana, Primulaceae*). Applications in Plant Sciences; 1 (6): 1200515; http://www.bioone.org/loi/apps.

**Mosallam, H. A. M. (2007):** Assessment of target species in Saint Katherine Protectorate, Sinai, Egypt. Journal of Applied Sciences Research; 3(6): 456– 469.

**Moustafa, A. A. (1986):** Ecological and Phytochemical Studies on some Species of Labiatae growing in Sinai. M.Sc. Thesis, Botany Department, Suez Canal University, Ismailia, Egypt. 237p.

**Moustafa, A. A. (1990):** Environmental Gradients and Species Distribution on Sinai Mountains. PhD. Botany Department, Faculty of Science, Suez Canal University, Ismailia, Egypt. 115p.

**Moustafa, A. A. and Klopatek, J. M. (1995):** Vegetation and landforms of the Saint Catherine area, southern Sinai, Egypt. Journal of Arid Environments; 30: 385–395.

**Moustafa, A. M. and Zayed, A. M. (1996).** Effect of environmental factors on the flora of alluvial fans in southern Sinai. Journal of Arid Environments; 32: 431– 443.

**Peet, R. K. (1988):** Forests of the Rocky Mountains. In: M.G. Barbour, and W.D. Billings, (eds.): North American Terrestrial Vegetation. New York: Cambridge University Press, 434p.

**Raunkiaer, C. (1934):** Life Forms of Plants and Statistical Plant Geography. Arno press, A New York Times Company, New York, 620p.

**Raven, P. H. (1964):** Catastrophic selection and edaphic endemism. Evolution; 18: 336–338.

**Said, R. (1962):** The Geology of Egypt, Elsevier Press, Amsterdam, 348p.

**Saker, M.; El-Demerdash, M. and Allam, M. A. (2011):** In vitro propagation and genetic characterization as effective tools for conservation of Silene *leucophylla*, grown in St. Katherine Protected Area, Sinai, Egypt. Journal of Genetic Engineering and Biotechnology; 9: 21–27.

**Shabana, H. A. M. (2013):** Variability among *Phlomis aurea* Decne. Populations in Southern Sinai. M. Sc.thesis, Botany Department, Faculty of Science, Tanta University. 246p.

**Shaltout, K. H. and Ayyad, M. A. (1988):** Structure and standing crop of Egyptian Thymelaea hirsuta populations. Vegetatio; 74: 137–142.

**Shaltout, K. H.; El- Halawany, E. F. and El- Kady, H. F. (1996):** Consequences of protection from grazing on diversity and abundance of the coastal low land vegetation in Eastern Saudi Arabia. Biodivers. Conserv., 5: 27–36.

**Shehata, A. A. and Kamel, W. M. (2007):** A contribution to the palynological studies of the endemic flora of Sinai, Egypt. Bot. Stec.; 11: 9–16.

**Shmida, A. (1984):** Endemism in the flora of Israel. Botanische Jahrbucher fur Systematik Pflanzengeschichte und Pflanzengeographie; 104: 537–567.

**Strid, A. (1986):** The mountain flora of Greece with special reference to the Anatolian element. Proc. R. Soc. edinb. Sect. B (Biol. Sci.); 89: 59– 68.

**Täckholm, V. (1974):** Student's Flora of Egypt (2nd ed.). Cairo Univ. Coop. Print. Co., Beirut, 888p.

**Titshall, L. W.; O'Connor, T. G. and Morris, C. D. (2000):** Effect of long-term exclusion of fire and herbivory on the soils and vegetation of sour grassland. African Journal of Range and Forage Science; 17: 70– 80.

**Trinder-Smith, T. H.; Lombard, A. T. and Picker, M. (1996):** Reserve scenarios for the Cape Peninsula: high, middle and low road options for conserving the remaining biodiversity. Biodiversity and Conservation; 5: 649–669.

**White, F. (1993):** The AETFAT chrological classification of Aftrica: history, methods and applications. Bull. Jard. Bot. Nat. Belg.; 62: 225– 281.

**Wickens, G. E. (1976):** The Flora of Jebel Marra. Kew Bull. Add. Ser. 5.

**Wickens, G. E. (1977):** Some of the phytogeographical problems associated with Egypt. Publications Cairo University Herbarium, 7 & 8: 223–230.

**Wood, E. F.; Sinpalan, M.; Beven, K. and Band, L. (1988):** Effects of spatial variability and scale with implications to hydrological modelling. Journal of Hydrology; 102: 29–47.

**Zaghloul, M. S.; Hamrick, J. L.; Moustafa, A. A.; Wafaa, M. Kamel and El-Ghareeb, R. (2006):** Genetic diversity within and among Sinai populations of three Ballota Species (Lamiaceae). Journal of Heredity; 97 (1):45–54.

**Zahran, M. A. (1989):** Principles of Plant Ecology and Flora of Egypt. Dar El Nashr for Egyptian Universities, El Wafa Libirary, 388p.

**Zahran, M. A. and Willis, A. J. (2009):** The Vegetation of Egypt. London, 2nd. ed., Springer Publisher, Netherlands; 437p.

**Zohary, M. (1966):** Flora Palaestina. Part l. Israel Acad. Sci. and Humanities. Jerusalem.

**Zohary M (1972):** Flora Palaestina. Part II. Israel Acad. Sci. Human. Jerusalem. 486p.

**Zohary, M. (1973):** Geobotanical Foundations of the Middle East, Vols. 1 and 2. Gustav Fischer, Verlag, Stuttgart, 739p.

*Received on 26/ 2/ 2015*

# الملخص العربى

## الأنواع النباتية المتوطنة في سيناء – مصر مع الاشارة لمحمية سانت كاترين: ١- الدراسات البيئية

محمود عبد القوى زهران[١] وفاء محروس عامر[٢]
سامى عبد العزيز عافيه[٣] عمران ناصر غالى[٤]

[١] قسم النبات – كلية العلوم – جامعة المنصورة
[٢] قسم النبات – كلية العلوم – جامعة القاهرة – مصر
[٣] قسم الأصول الوراثية النباتية – مركز بحوث الصحراء – القاهرة – مصر
[٤] قسم البيئة والمراعي– مركز بحوث الصحراء – القاهرة – مصر

الأنواع النباتية المتوطنة عادة ما تكون نادرة وتقتصر في نموها على مناطق جغرافية صغيرة، لذلك تحتاج اهتماما خاصا لحفظها.الأنواع النباتية المتوطنة بمحمية سانت كاترين، جنوب سيناء سبعة عشر نوعا،تم دراسة اثنتي عشر نوعا منها.

اوضحت الدراسة مدي اختلاف التوزيع الجغرافي لنباتات الدراسة داخل 36 موقع . نبات العوروز حقق اعلي نسبة تواجد (97%) بينما حققت نباتات *Silene leucophylla arabica* و *Ballota kaiseri* و *Primula boveana* و *Rosa* اقل نسبة تواجد وهي: 2.7 و 2.7 و 13.8 و (22.2 %) علي التوالي. نباتات الدراسة تنمو في أربعة أنواع من الموائل وهي: wadi bed و gorge و slope و basin. موائل gorge هي أنسب الموائل لنمو الأنواع المتوطنة حيث تؤوي عشرة أنواع ممن شملتها الدراسة تمثل 83.33% تليها المنحدرات slope والتي تؤوي ثمانية أنواع يمثلون 66.66% ثم wadi bed ويحوي سبعة أنواع تمثل 58.33% وأخيرا basin والذي يضم ستة أنواع تمثل 50%.

نباتات الدراسة تنتمي إلى ثلاثة أشكال مختلفة للحياة هي: Hemicryptophyte (50%) وتضم ستة أنواع وهي السائدة، و chamaephyte (41.66%) وتشمل خمسة أنواع و Nano-phanerophyte (8.33%) ويمثلها نوع وحيد وهو Rosa arabica. جميع الأنواع التي شملتها الدراسة هي عناصر أحادية التوزيع الجغرافي، متوطنة لمحمية سانت كاترين داخل Saharo-Sindian chorotype.

كشفت الملاحظات الحقلية خلال هذا العمل أن جميع الأنواع المتوطنة لمحمية سانت كاترين تميزت بقلة عددها، وانخفاض عدد البذور ومعدل بقاء البادرات وهذه من بين العوامل التي تؤدي إلى اختفاء هذه الأنواع من الموائل البرية بمحمية سانت كاترين وادراجها ضمن قائمة الأنواع المهددة.

JOESE 5

# ENDEMIC SPECIES IN SINAI PENINSULA, EGYPT, WITH PARTICULAR REFERENCE TO SAINT KATHERINE PROTECTORATE: I- ECOLOGICAL FEATURES

**Zahran M. A.[1]; Amer M. Wafaa[2]; Afiah A. Samy[3]; and Ghaly N. Omran[4]**

[1]*Botany Dept., Faculty of Science, Mansoura Univ., Egypt.*

[2]*Botany and Microbiology Dept., Faculty of Science, Cairo Univ., Egypt.*

[3]*Plant Genetic Resources Dept., Desert Research Center, Egypt.*

[4]*Ecology and Ranges Dept., Desert Research Center, Egypt.*

# Reprint

*from*

**Journal of Environmental Sciences, 2015; Vol. 44, No. 4 : 589-609**


**http://eulc.edu.eg/jes**

**P-ISSN 1110-192X**
**e-ISSN 2090-9233**