

# Studies on five *Silene* L. Taxa in Saint Catherine Protectorate, South Sinai, Egypt

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## Abstract

This work aims to document morphological and anatomical features of *Silene* L. taxa in Saint Catherine protectorate as well as their distribution. Five *Silene* taxa are investigated representing 17% of all Egyptian *Silene*; three of these taxa are endemic. Investigated taxa grow in 5 microhabitats (slope, gorges terraces, farsh (basin) and wadis) either alone or associated with other species. The total populations of three *Silene* taxa (*S. odontopetala* Fenzl subsp. *congesta* Boiss., *S. leucophylla* Boiss., and *S. oreosinaica* Chowdhuri; the latter two are endemics) were represented by a low number of individuals (60–140) and are threatened by abiotic and biotic risks which may lead to their extinction.

**Keywords:** Anatomy, Endemic, Morphological characters, *Silene*, Sinai.

## 1. Introduction

Saint Catherine Protectorate (SKP) extends over virtually the entire mountain massif of southern Sinai, with an area of about 4350 km<sup>2</sup>. and lies between 33° 55' to 34° 30'E and 28° 30' to 28° 35'N (Moustafa and Klopatek 1995). The diversity of both land-forms and geologic structures of Saint Catherine protectorate leads to the differentiation of a number of microhabitats, each of which has its peculiar environmental conditions and unique flora which is rich in medicinal, rare and endemic plants. Six landforms (microhabitats) types can be recognized viz. wadis, terraces, slopes, gorges, farsh (basin) and caves (Khedr 2007). Environmental conditions and human impact such as over collection, over grazing, and feral donkeys have a significant influence on diversity and distribution of the threatened endemic and medicinal plants (Abd El-Wahab *et al.* 2004; Assi 2007 ; Omar *et al.* 2015).

Caryophyllaceae includes about 100 genera (3000 species) distributed mainly in the Mediterranean and Irano-Turanian areas (Hernández-Ledesma *et al.* 2015). According to (Bittrich 1993), three subfamilies were recognized: -Viz.: Alsinoideae –Burnett., Caryophylloideae. Arn. and Paronychioideae -A.St.Hil.ex Fenzl Caryophylloideae was classified by Bittrich (l.c.) into three tribes, i.e. Caryophylleae, Drypideae and Sileneae.

The genus *Silene* comprises about 700 species (Boshra and Farhad 2014) distributed mainly in north temperate regions and especially in the Mediterranean and West Asia and also found in Tropical and South Africa (Abdul Ghafoor 1978); the Mediterranean region hosts the majority of the *Silene* taxa (Oxelman *et al.* 1997).

In the flora of Egypt *Silene* is represented by 29 taxa including 2 subspecies, and 11 varieties (Boulos, 1999 ; 2009) distributed all over the country especially in Sinai which hosts 19 taxa, among them seven taxa hosts in Saint Catherine protectorate (about 25% of the Egyptian *Silene* spp.) viz. *S. arabica* Boiss. *S. linearis* Decne. *S. odontopetala* Fenzl subsp. *congesta* Boiss., *S. villosa* Forssk., *S. leucophylla* Boiss., *S. schimperiana* Boiss. and *S. oreosinaica* Chowdhuri. The last three are endemic (Radford 2011; Ghaly 2015).

The aims of the present study are: (1) to provide detailed morphological characters of five studied taxa based on field observation, (2) to provide an account about twelve anatomical characteristics of the studied taxa, and (3) to give ecological notes about *Silene* taxa from Saint Catherine protectorate

## 2. Material and Methods

### 2.1. Data collection (morphological and ecological data)

Eighty-five quadrates (5 × 5 m) were surveyed in the period from October-2015–August-2016. Morphological characters were studied and the parameter measured from freshly collected specimens; 20 plants per taxa were examined as well as herbarium specimen kept in Cairo University "CAI" and Saint Catherine protectorate "SKPH" herbaria. The morphological terminology follows Stearn (1973). Microhabitats, number of individuals, taxa frequency, density, cover and abundance were also annotated. The threats were determined depending on field observation; we recorded any sign that may be a threat to the target species in each quadrate (Table 1). Identification and distribution in Egypt is based on Täckholm (1974) and

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Boulos (1999). Nomenclature, accepted name as well as synonyms, were verified using International Plant Names Index (IPNI) <http://www.ipni.org/ipni/plantnamesearchpage.do>.

Herbarium specimens were deposited in the Department of Botany and microbiology, Faculty of Science, Herbarium, Damietta University as well as in the herbarium of Saint Catherine Protectorate (SKPH). The distribution maps were prepared using ArcGIS ver. 10.2. and Cluster analysis using past software version 3.11. <https://folk.uio.no/ohammer/past/Past>.

## 2.2. Anatomy

The sections were taken from a fresh leaf and third internode and prepared according to Johansen (1940). Staining was carried out using the safranin and fast green according to Sass (1958). The samples were examined and photographed by using XSZ-N107 research microscope fitted with premiere MA88-900 digital camera.

## 3. Results and Discussion

### 3.1. Systematic treatment

#### Key of investigated taxa

- 1 Flowers solitary .. .....*S. schimperiana*  
 1 Flowers not as above.....2  
 2a Calyx oblong-cylindrical, Petals purple to whitish violet. Basal leaves ovate to spatulate, 0.6–3 × 0.1–0.8 cm. arranged in rosette shape, olive color; *S. leucophylla*  
 2b Calyx tubular, Petals white, leaves linear 1 -2 x 0.1-0.2cm..... *S. linearis*  
 2c Calyx sub sessile, campanulate; nerved with violet nerve, Inflorescence dichasium cyme, congest, (Capitate), Petals pale violet (pink). Basal leaves oblanceolate 1-4.6 x 0.3 - 0.8 cm .....*S. odontopetala* subsp. *Congesta*  
 2d Calyx tubular, nerved with yellow nerve, hairy. Petals white with very pale pink edges. Basal leaves lanceolate, 0.4- 4.5cm. x0.1 - 0.9cm arranged in rosette shape;  
 .....*S. oreosinaica*  
*Silene schimperiana* Boiss. Diagn. Pl. Orient. ser. 1, 1:31 (1942); Boiss., Fl. Orient. 1:641 (1867); Dinsmore in Post & Dinsmore, Fl. Syria ed. 2, 1:187 (1932); Täckh., Stud. Fl. Egypt ed. 1:390 (1956); Hassib & Montasir, Man. Fl. Egypt 1:94 (1957); Täckh., Stud. Fl. Egypt ed. 2: 86 (1974); Hosny *et al.*, Taecholomia, 14:13 (1992); Boulos, Fl. Egypt 1:62 (1999); Hosny in El Hadidy, Fl. Aegyptiaca, 1(2):129 (2000); Boulos, Fl. Egypt checklist: 36 (2009).

Type: In rupibus Jugi Sinaici Arabiae loco Bostan dicto; *Schimper* 422.

Perennial, with woody structure at the base, up to 120 cm. long. Stem cylindrical with swollen nodes, glabrous, internode 2-6 cm. long. Basal leaves linear to spatulate 1.4-8.x0.2 0.5cm. with acute apex, entire margin, symmetrical base, petiolate, blue green in color, arranged in rosette shape. Cauline leaves linear to spatulate, opposite decussate, with acute apex, entire margin, symmetrical base. Flowers solitary. Calyx oblong-cylindrical 2-2.7 cm. long, 10 nerved, glabrous, 5 united sepals. calyx teeth, triangular with acute apex 2 – 3 mm.

long, calyx facing sun nerved by violet color (field observation). Petals five white in the upper side and yellowish in the back side, sometimes with violet nerves, 3.5 - 5.2 cm. long (with claw length 1.5 - 2.7 cm and limb 2 -2.7 cm.). Fruit oblong capsule 2.8 cm in length. (Figure 3E, 4 E and table 1).

Flowering and fruiting times: Flowering time March – May; fruiting time July–August.

Habitat: Slope, terraces, gorges, and farsh.

**Distribution in Egypt:** Rare, endemic, confined to southern Sinai.

Representative specimens: South Sinai, July 1943, Hassib *et al.* s.n. (CAI); South Sinai, Step-way to Gebel Musa; 11 May 1956; Täckholm s.n. (CAI); South Sinai, Wadi Talaa, 8. Oct.1983, Hadidi *et al.* s.n. (CAI); South Sinai, SKP, Wadi Gebal region, Al shaq, 9-April-2004, Fayed *et al.* s.n (SKPH); South Sinai, SKP, El Geragenia ,22-Dec-2015, El Gamal, s.n., (Demitta university, faculty of Science herbarium); South Sinai, SKP., Gabal El Dair, 21-5-2016, El Gamal, s.n., (SKPH).

*Silene leucophylla* Boiss., Diagn. Pl. Orient. 1.1:29 (1842); Boiss., Fl. Orient., 1:634 (1867); Täckh., Stud. Fl. Egypt, ed. 1:390 (1956); Hassib & Montasir, Man. Fl. Egypt 1:94 (1957); Täckh., Stud. Fl. Egypt ed. 2:85 (1974). Hosny *et al.*, Taecholomia, 14: 11 (1992); Boulos, Fl. Egypt, 1:61 (1999); Hosny in El Hadidy, Fl. Aegyptiaca 1, 1(2): 130 (2000); Boulos, Fl. Egypt checklist: 36 (2009).

Type: SINAI: *In rupibus et praeurtis umbrosis montis St. Catharinae*, 28 May et 6 June, 1835, *Schimper* 297, 351 (HBG holotype).

Perennial, with woody structure at the base up to 30 cm long. Stem, erect, hairy, cylindrical, internode length 2–5 cm. Basal leaves ovate to spatulate, rarely orbicular 0.6–3 × 0.1–0.8 cm arranged in rosette shape; petiolate, petiole 0.4–3 cm. long, olive color, with acute apex and entire margins. Cauline leaves ovate to spatulate 0.3–1.2 × 0.1–0.5 cm. opposite decussate, petiolate, with acute apex and entire margins. Inflorescence cymose; with 3-9 flowers, pedicelled; Pedicel length 0.4–0.7 cm. calyx oblong-cylindrical, 1.2-1.9 x 0.1-0.3cm., 10 nerved, hairy, calyx teeth triangular c.3mm.long. Petals 5 purple to whitish violet to violet, 2.8–5.5 cm long (with claw length 0.5–0.7 cm and limb 2–2.3 cm. long). Fruit oblong ovoid capsule 1.9 cm. long (Figure 3A, 4A and table 1).

Flowering and fruiting times: Flowering time March–April, fruiting- time July–September.

Habitat: Slopes, terraces and gorges (rocky crevices).

**Distribution in Egypt:** Rare, endemic confined to Saint Catherine protectorate (South Sinai).

Representative specimens: : On the step-way to Gebel Musa, 11 May 1956, Täckholm s.n. (CAI); Wadi Gebal region, Al Shaq, 13-May-2004, Fayed *et al.* s.n. (SKP H);Shaq Mousa, 22-May-2016, El Gamal, s.n. (SKPH & Damiatta University Herbarium); El Geragenia, 22-December-2015, El Gamal, s.n. (SKPH); El Gabal El Ahmar, 26-May-2016 El Gamal, s.n. (CAI & SKPH).

*Silene linearis* Decne. Fl. Sinaica, ser. 3, 2:376 (1835); Boiss., Fl. Orient., 1:602 (1867); Aschers, & Schweinf., Fl. Egypte 2:47 (1887); Sickenb., Mem. Inst., Egypt. 4, 2:185 (1901); Muschl., Man., Fl. Egypt 1:339 (1912); Ramis, Best.-Tabel 1. Fl.

Aegypt.: 76 (1929); Täckh., Stud.Fl. Egypt, ed. 1:392 (1956); Hassib & Montasir, Man. Fl.Egypt. 1:95 (1957); Täckh., Stud. Fl. Egypt ed.2:86 (1974); Hosny *et al.*, Taecholomia, 14:19 (1992); Boulos, Fl. Egypt 1:64 (1999); Hosny in El-Hadidy Fl. Aegyptiaca,1(2): 122 (2000); Boulos, Fl. Egypt checklist :37 (2009).

Type: Le desert du Sinai; Bové 178 (P, holotype).

=*Silene arenosa* K. Koch, in Linnaea 23, 6:712 (1851).

Annual or Short perennial herb, erect, up to 90 cm long. Stem, glabrous, cylindrical, branching from the base, internodes 1.8-5cm.long. Basal leaf linear 1 -2 x 0.1-0.2cm., with acute apex, entire margin, sessile, symmetrical base and hairy. Cauline leaves linear (0.5-1.2. x 0.1cm), opposite decussate with acute apex, entire margin, sessile and hairy. Inflorescence cymes. Calyx tubular, 10 nerved; 1-2cm.long, with short triangle to linear teeth. Petals five, white in color, 1-1.5 cm. long (with claw 0.4 -0.6 cm. long and limb 0.6-0.9 cm. long. Fruit cylindrical capsule. (Figure 3 B, 4 B and table 1).

Flower ing and fruiting times: Flowering time March - May, fruiting time July–August.

Habitat: Slope, gorges and terrace.

**Distribution in Egypt:** Eastern desert, Red coastal strip, Sinai.

Representative specimens Sinai : El Raha plain, 13.May.1956, Hadidi, s.n. (CAI); Wadi Feiran, 21Aug.1982,Hadidi *et al.*, s.n. (CAI); Wadi El Ghadir,, 4.Feb.1961, Täckholm *et al.*, s.n. (CAI); South Sinai ,Wadi Thamman, 9-April-2004, Fayed *et al.*, s.n (SKPH); Wadi Al-Arbaa'en SKP, 2-May-2004, Shaltout *et al.*, s.n (SKPH); Wadi Ferian, SKP, 7-May-2004 Shaltout *et al.*, s.n. (SKPH). South Sinai Wadi El Fara'a, 6-May-2004, Shaltout *et al.*, s.n. (SKPH); South Sinai, Gabal El Dair, 4-Feb-2016 El -Gamal s.n. (SKPH).

*Silene odontopetala* Fenzl subsp. *congesta* Boiss.

*Silene odontopetala* Fenzl var. *congesta* Boiss. Fl. Orient. 1:626 (1867); Täckh., Stud. Fl. Egypt ed., 1:389(1956); Hassib & Montasir, Man. Fl. Egypt, 1:93 (1957); Täckh., Stud. Fl. Egypt ed. 2:85 (1974); Hosny *et al.*,Taecholomia, 14:13 (1992) ; Boulos, Fl. Egypt 1:61 (1999); Hosny in El Hadidy, Fl. Aegyptiaca, 1(2):131 (2000); Boulos, Fl. Egypt Checklist :36 (2009).

Type: In -monte Sinaico St Catherinae; *Schimper* 296 (G, -holotype)

*syn. S.-sinaica* Boiss., Diagn. p1. Orient. ser. 1,1:25 (1843);

Perennial, with woody structure at the base, 20-25 cm .long. Stem hairy, erect or ascending, internode 2 - 6 cm. long. Basal leaves oblanceolate 1-4.6 x 0.3 - 0.8 cm. with acute apex, entire margin, symmetrical base, petiolate. Cauline leaves oblanceolate 0.5-1.2. x 0.2 - x 0.4cm opposite decussate, acute, entire, symmetrical. Inflorescence dichasium cyme, congest, (capitate). Calyx sub sessile, campanulate C.0.9 cm. long, broad, hairy, pedicel 0.2 - 0.5 cm. long, 10 nerved. Bract ovate, 0.4 - 0.8 cm. long usually with medial violet nerve, Petals five white or pink c.1.3 cm. long (with claw length 0.4 -0.5 cm. long and limp 0.9 cm. long). Fruit ovate capsule0.4 - 0.8 cm. long. (Figure 3 C, 4 C and table 1).

Flowering and fruiting times: Flowering time March - May, fruiting time July–September

Habitat: Slops, (Rocky crevices).

**Distribution in Egypt:** Rare, confined to southern Sinai.

Representative specimens: South Sinai, Abo Mahsour, 23-May-2016, El Gamal, s.n. ( Damietta university herbarium & SKPH). South Sinai: AboMahsour, South Sinai: El Gabal el Ahmar, 26-May-2016, El Gamal,s.n. (CAI, SKPH)

*Silene oreosinaica* Chowdhuri .Not. Roy. But. Gard. Edinb. 22:269 (1957); Hosny *et al.*, Taecholomia, 14:15 (1992); Boulos, Fl. Egypt 1:62 (1999); Hosny in El Hadidy Fl. Aegyptiaca, 1(2):131 (2000); Boulos, Fl. Egypt checklist :36 (2009); Rabei *et al* (2016) Scientific Journal for Damietta Faculty of Science 6 (1) 2016.

Type: Sinai, in Rupium fissuris montis St. Catharinae; *Schimper* 352 (1835); (K, holotype).

Perennial, with woody structure at the base up to 25 cm. long. Stem, hairy, cylindrical; internode up to 5 cm. long. Basal leaves lanceolate, 0.4- 4.5. x0.1 - 0.9 cm. arranged in rosette shape with acute apex, entire margins, symmetrical base and sessile. Cauline leaves lanceolate, smaller than basal leaves 0.4-2.5 x0.1 - 0.2 cm, opposite decussate with acute apex, entire margin, symmetrical base and sessile, Inflorescence racemes, pedicle; Pedicel length 0.5 cm. long. Calyx tubular 0.8 -1.2 cm. long, 10 nerved with yellow nerve, hairy. Bract lanceolate. Petals 5 white in color with very pale pink edges 1.1- 1.9 cm. long (claw 0.4 -0.6 cm. long and limp 0.7-1.2 cm. long). Petals that exposed to the sun are converted to rose color (field observation). Fruit ovoid cylindrical Capsule, 0.8 -1.2 cm. long. (Figure 3D,4 D and table 1).

Flowering and fruiting times: Flowering time during spring months usually March – May; rarely during December and January fruiting time July–October.

Habitat: Slops, (Rocky crevices).

**Distribution in Egypt:** Rare, endemic confined to Saint Catherine protectorate( southern Sinai).

Representative specimens: South Sinai: wadi Feiran, 21.Aug. 1982, Hadidi *et al.* s. n. (CAI); South Sinai: Gebel Catherine, Ein Shinar, 9.Oct. 1983, Hosny s.n. (CAI); South Sinai: SKP, Shaq Mousa ,7-Jan-2016 El Gamal, s.n. (SKPH); South Sinai: SKP ,Shaq Mousa, 25-March-2016, El Gamal, s.n. ( CAI & SKPH); South Sinai: SKP ,Om Mesla, 22-May-2016, El Gamal,s.n. (SKPH); South Sinai: SKP, Om Mesla ,20-Jun-2016, El Gamal, s.n. (Damietta university faculty of Science herbarium).

### 3.2. Anatomical characters (Figures 5A–E and table 3)

The transverse section of the stem revealed that it is circular, solid stem, in all studied taxa; the epidermis consisting of single layer of rectangular-oval cells in *S. leucophylla*, *S. linearis*, *S. oreosinaica* while consisting of single layer of rectangular cells in both *S. odontopetala* subsp. *Congesta* and *S.schimperiaana* . Anisocytic and Diacytic stomata are present in *S. odontopetala* and *S.schimperiaana* respectively. Druses are consecrated in both cortex and pith for all studied species except *S. oreosinaica* observed in cortex only, raphides observed only in *S. schimperiaana*.

The transverse section of the lamina and epidermal surfaces revealed that leaves of the studied taxa were dorsiventral; thick walled parenchyma is present in all

taxa except in *S. schimperiana*; only *S. linearis* displays leaves with sclerenchyma patches. Druses are present in all studied taxa. Raphides were present in *S. leucophylla*, and *S. odontopetala* subsp. *congesta* and absent in the other taxa. Oil globules were present only in *S. schimperiana*. Stomata type is anisocytic in *S. leucophylla*, *S. odontopetala* subsp. *congesta* and *S. oreosinaica*, while it is diacytic in two species viz. *S. linearis* and *S. schimperiana*. Our present results are in agreement with Metcalfe and Chalk (1950) who reported that in general, the stomata are diacytic, i.e. Caryophyllaceous type, but with some exceptions where stomata are anisocytic and calcium oxalate crystals are commonly found in *Diathus* and *Silene*.

Cluster analysis of the anatomical characters of five *Silene* taxa identified two main clades: the first one included *S. odontopetalia* and *S. oerosinica* with sub clade included *S. leucophylla* and the second one included *S. lineares* and *S. schimperina*. (Figure 6). Stomata type; stem epidermis, raphides, oil globules are significant characters to separate studied taxa from each other.

### 3.3. Ecological notes

According to Khedr (2007), six microhabitats can be recognized in Saint Catherine protectorate: wadi bed, Terraces, slopes, gorges, Farsh and caves. Investigated *Silene* taxa are distributed in five out of these six habitats, i.e. slope, gorge, terraces, farsh (Basin) and wadis. *S. schimperiana* is recorded in five microhabitats with high number of individuals, and density. The average frequency in three microhabitats are slope, gorges terraces was 34.12% and 47.06% for *S. linearis* *S.* and *S. leucophylla* respectively, density 0.07 for both species, while the covering was 1.40/2.65 and abundance 3.50/5.17

respectively for *S. leucophylla*, and *S. linearis*, while *S. odontopetala* and *S. oreosinaica* were recorded only in the slope microhabitat with frequency 15.29/12.94% respectively, density of 0.03 for both taxa, cover of 0.47/0.71 respectively and abundance of 4.62/5.73 respectively.

In eco-geographical terms, *Silene oreosinaica* is restricted in two sites, *S. odontopetala* subsp. *congesta* is recorded in three sites, while *S. schimperiana*, *S. leucophylla* and *S. linearis* are widely distributed in Saint Catherine protectorate (Figure 2 A-D and table 3 ).

The studied taxa grow either alone or associated with other species. The most common associates are *Chiliadenus montanus* (Vahl) Brullo, *Stachys aegyptiaca* Pers. *Centaurea scoparia* Sieber ex Spreng., *Seriphidium herba-alba* (Asso) Soják *Scrophularia libanotica* Boiss., and *Galium sinaicum* (Delile ex Decne) Boiss.

The population size of the studied *Silene* species is critically for *S. odontopetala* subsp. *congesta*, *S. leucophylla*, and *S. oreosinaica* (the last two are endemic) with total number of individuals in all studied area ranging between 60 and 140.

*S. odontopetala* subsp. *congesta* and *S. oreosinaica* are restricted to high altitude localities (2055–2313m a.s.l.), while *S. leucophylla* and *S. linearis* recorded at 1770–2226 m a.s.l., and *S. schimperiana* at 1328–2318 m a.s.l.

The threat of genetic erosion of *Silene* is a result of abiotic effect such as scarcity of water, or biotic factors like the effect of overgrazing by domestic and wild animals, especially flowering parts overgrazing. Therefore, it could lead to the extinction of the endemic species from Egypt; the result obtained is in agreement with previous studies like Assi (2007), Omar *et al* (2015; 2017) and Ghaly (2015).



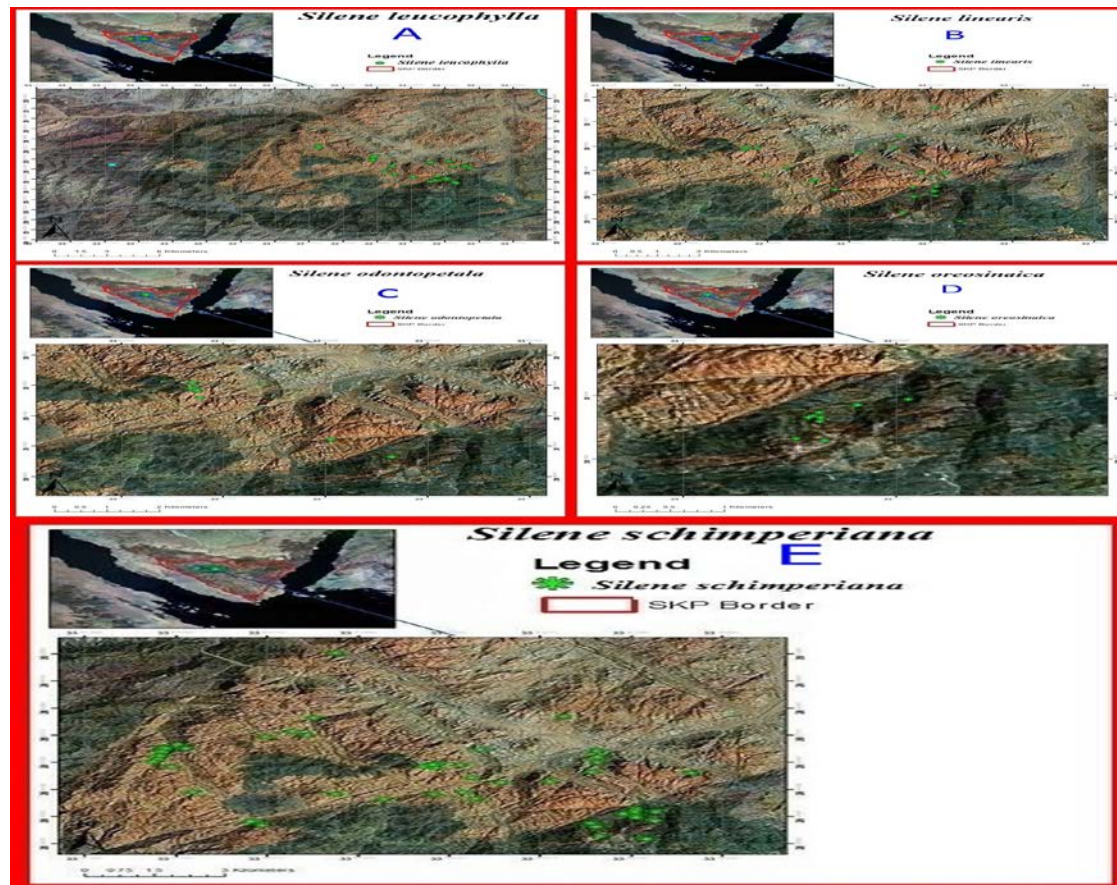
**Figure 1.** Showing SKP microhabitats A= wadi B= Terraces, C=Slope, D=George, E= Farsh (basin) and F= cave

**Table 1.** Morphological characters of *Silene* species

Character	<i>S. leucophylla</i>	<i>S. lineares</i>	<i>S. odontopetalia</i>	<i>S. oerosinica</i>	<i>S. schimperina</i>
longevity perennial	1	1	1	1	1
Height up to (cm.)	30	70	25	25	140
Stem ascending	0	0	1	1	0
Stem erect	1	1	1	1	1
Lanceolate basal leaves (B.L)	0	0	0	1	0
Linear(B.L)	0	1	0	0	1
Oblanceolate (B.L)	0	0	1	0	0
Ovate (B.L)	1	0	0	0	0
Spatulate (B.L).	1	0	0	0	1
Orbicular (B.L)	1	0	0	0	0
Basal leaf length (cm.)	3	2	4.6	4.5	8
Basal leaf width (cm.)	0.8	0.2	0.8	0.9	0.5
Lanceolate Cauline leaves (C.L)	0	0	0	1	0
Linear (C.L)	0	1	0	0	1
Oblanceolate (C.L)	0	0	1	0	0
Ovate (C.L)	1	0	0	0	0
Spatulate (C.L).	1	0	0	0	1
white petal	0	0	1	1	1
pink petal	0	0	1	1	0
violet petal	1	0	0	0	0
yellowish petal	0	1	0	0	0
leaf blade (entire)	1	1	1	1	1
Capsule: length (cm.)	1.9	2	0.4	1	2.8
Solitary flowers	0	0	0	0	1
cymes Inflorescence	1	1	1	0	0
racemes Inflorescence	0	0	0	1	0
Ave. diameter (cm)	11.3	15	10	12	25
Leaf length (cm)	0.4 – 2	1-2	1-4.6	1 -4.5	1.4-8
Leaf width(cm)	0.1 - 0.6	0.1-0.2	0.3-0.8	0.3-0.9	0.3-0.5
petiole length(cm)	0.4 -3	0	0	0	0
#flowers/ inflorescence	3-9	4	5 flowers in capitate	6	Solitary

**Table 2.** Anatomical characters of five *Silene* taxa.

Character	<i>S. leucophylla</i>	<i>S. lineares</i>	<i>S. odontopetalia</i>	<i>S. oerosinica</i>	<i>S. schimperina</i>
Stem shape	1	1	1	1	1
cortex (thick walled)	0	1	1	1	0
no. vascular bands	10	14	13	8	7
Druses in cortex	1	1	1	1	1
Druses in pith	1	1	1	0	1
Raphides in stem	0	0	0	0	1
Stomata in stem	0	0	1	0	1
leaf thick walled	1	1	1	1	0
Sclerenchyma patches	0	1	0	0	0
Leaf druses	1	0	0	0	0
Raphides in leaf	1	0	0	0	0
Prismatic crystals	1	0	0	0	0
Rounded mid rib	1	1	0	0	1
Semi-rounded mid rib	0	0	1	1	0
Anisocytic stomata	1	0	1	1	0
Diacytic stomata	0	1	0	0	1



**Figure 2.** *Silene* distribution maps, A= *S. leucophylla*, B= *S. linearis*, C= *S. odontopetala*, D= *S. oreosinaica* and E= *S. schimperiana*

**Table 3.** Ecological notes of *Silene* taxa

Parameter	<i>Silene</i> taxa				
	<i>S. leucophylla</i>	<i>S. linearis</i>	<i>S. odontopetala</i>	<i>S. oreosinaica</i>	<i>S. schimperiana</i>
Frequency (%)	47.06	34.12	15.29	12.94	69.41
Abundance	3.50	5.17	4.62	5.73	12.00
Density	0.07	0.07	0.03	0.03	0.33
Cover %	1.40	2.65	0.47	0.71	34.74
Microhabitat	Slope, gorges terraces. in all aspect except flat	Slope, gorges, terraces in all aspect except flat	Slop in north aspect	Slop in north aspect	Slope, terraces, gorges, farsh, wadi. in all aspect
Elevation (m a.s.l)	1770 - 2226	1772 - 2170	2106 -2313	2055 - 2310	1328 - 2318
Global Distribution	Endemic to SKP	Egypt, Palestine, Saudi Arabia	Egypt and Iran	Endemic to SKP	Endemic to SKP
SKP Distribution	El faraa, Shq mousa, Abu gifa, El Zawateen, El mealq, Abu Goose,. El Fara'a, Abu Walee, El Qalab, El Talaa ,El Gragenia ,Wadi Telah ,Farsh Shobie, Farsh el Safsafa, Earsh elia, Gabel katerina ,El gabal el Amher, Wadi el Shak and El Mathar	Wadi El arbeen, El faraa ,Shq mousa, Abu mahshoue ,Ab uo goose ,Gabal El Dair, El Gabal el Amher ,Wadi el Shak Shreg ,El Mathar, El Meserdy and El Galat El Azrak	Restricted in 3 sites farsh abu mhasour region, el Gabal el Ahmer and Om Meslla region.	Recorded in two sites shak mousa (maeen shinera) and Om Meslla in Gabal Katerina region.	Wadi El arbeen ,El faraa ,Shq mousa, Abu Gifa, El Zawateen, El Mealq, Abu Mahshoue ,W. El Fara'a ,El Qalab, El Talaa El Gragenia, Rehibe nada, Shq telaha, Gabel katerina ,El Gabal El Amher ,Shreg ,El Shikh Awad ,Wadi El Shak,El meserdy El Galat El Azrak
Associated species	Mostly solitary or associated with one or more of <i>Pterocephalus sanctus</i> . <i>Diploxix harra</i> . <i>Chiliadenus montanus</i> , <i>Galium</i>	<i>Chiliadenus montanus</i> , <i>Stachys aegyptiaca</i> , <i>Centaurea scoparia</i> , <i>Seriphidium herba-alba</i> ,	Mostly solitary or associated with <i>Scrophularia libanotica</i> and /or <i>Galium sinaicum</i>	Mostly solitary or associated with <i>Scrophularia libanotica</i> , and <i>Tanacetum sinaicum</i> .	<i>Achillea fragrantissima</i> . <i>Alkana orientalis</i> . <i>Anarrhinum pubescens</i> , <i>Bufonia multiceps</i> , <i>Chiliadenus montanus</i> , <i>Cotoneaster orbicularis</i> <i>Crataegus sinaica</i> , <i>Deverra triradiata</i> ,

*sinaicum* *Arenaria deflexa*.  
*Arenaria deflexa*, *Gypsophila*  
*Polygala sinaica*, *capillaris*,  
*Phagnalon nitidum*, *Nepeta*  
*Stachys aegyptiaca*, *eptemcrenata*,  
*Tanacetum sinaicum*. *Silene*  
*schimperiana*,  
*Teucrium*  
*leucocladum*  
*Phlomis aurea*.

*Echinops glaberrimus*,  
*Fagonia Arabica*, *Ficus palmate*,  
*Matthiola longipetala*, *Papaver*  
*decaisnei*, *Plantago sinaica*,  
*Pterocephalus sanctus*,  
*Seriphidium herba-album*, *Stachys*  
*aegyptiaca*,  
*Nepeta septemcrenata*,  
*Tanacetum sinaicum*, *Phlomis*  
*aurea*, *Origanum syriacum*,  
*Kickxia acerbiana*, *Teucrium*  
*polium*, *Thymus decussatus*,  
*Gypsophila capillaris*,  
*Silene linearis*,  
*Verbascum sinaicum*

Threats The threat of genetic Silene is a result of abiotic effect such as scarcity of water, or biotic one like effect of grazing by domestic and wild animal.

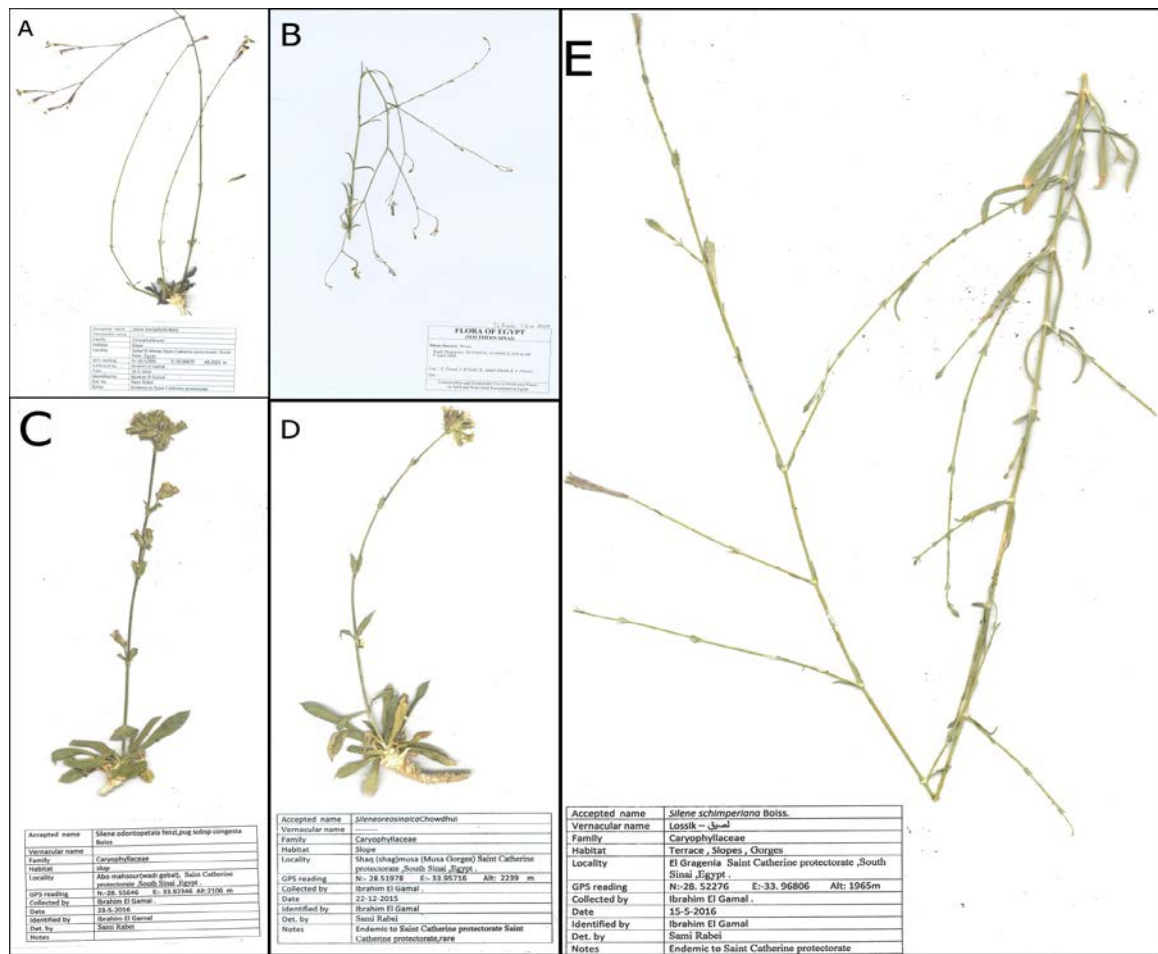
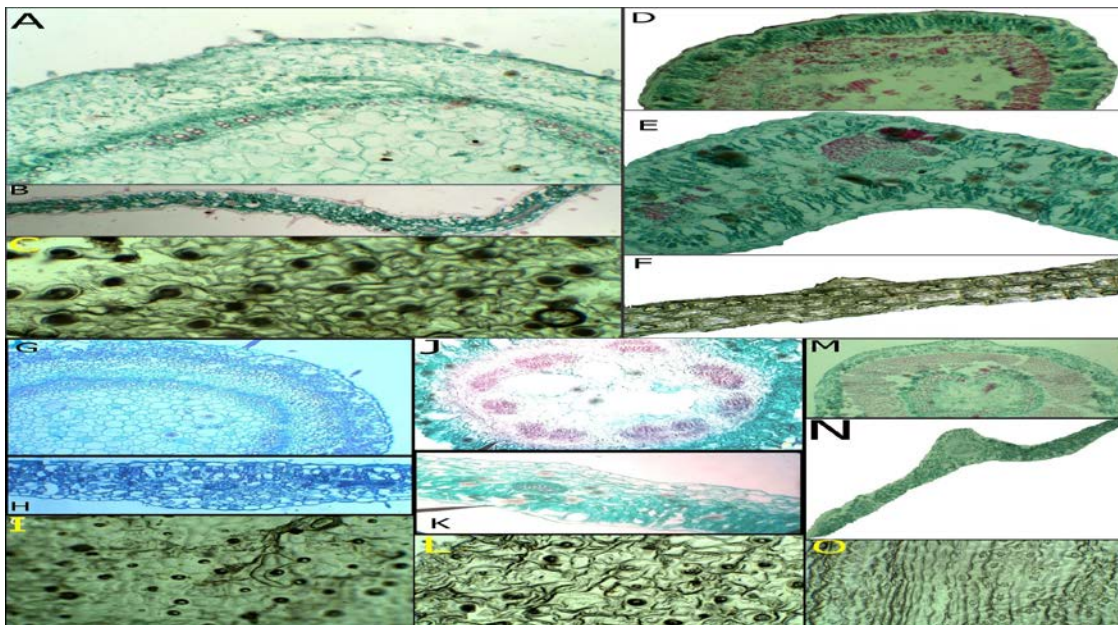


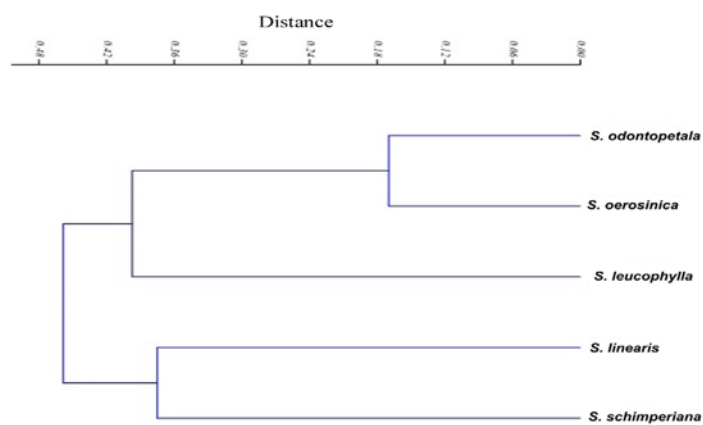
Figure 3. *Silene* herbarium specimen, A= *S. leucophylla*, B= *S. linearis*, C= *S. odontopetala*, D= *S. oreosinaica* and E= *S. schimperiana*



**Figure 4.** Photos of A= *S. leucophylla*, B= *S. linearis*, C= *S. odontopetala*, D= *S. oreosinaica* and E= *S. schimperiana*



**Figure 5.** A, B and C showing *S. leucophylla* stem, leaf T.S and epidermal cells. D,E and F showing *S. linearis* stem, leaf T.S and epidermal cells, G, H and I showing *S. odontopetala subsp. congesta* stem, leaf T.S and epidermal cells, J,K and L showing *S. oreosinaica* stem, leaf T.S and epidermal cells M,N and O showing *S. Schimperiana* stem, leaf T.S and epidermal cells



**Figure 6.** Dendrogram showing the relationship among *Silene* taxa



#### 4. Conclusion

Field observations revealed that *Silene* populations of the investigated taxa have restricted population, no new seedling, and low seed fitting. Additional reasons include scarcity of water, overgrazing (especially flowering parts) by domestic and wild animals as well as over collection for scientific research.

Therefore, these factors could cause the extinction of the endemic species from Egypt. A scientific program aiming at controlling the continuous destruction of *Silene* taxa in Saint Catherine Protectorate by in-situ conservation (restoration and rehabilitation program) and ex-situ conservation (seed preservation in seed bank, more control on plant collection for different purposes e.g. collection for scientific purposes and as green fodder) of these taxa is urgently needed.

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