International Journal of Natural and Engineering Sciences 2 (2): 59-63, 2008
ISSN: 1307-1149 www.nobel.gen.tr

Taxonomic Revision of Silene L. Sect.Brachypodae (Boiss.) Chowdhuri (Caryophyllaceae)

*Semra KILIÇ Hasan ÖZÇELİK
Süleyman Demirel University, Faculty of Science and Arts, Biology Department,32260-Isparta/Turkey

*Corresponding author
e-mail: semra@fef.sdu.edu.tr

Received:December 05, 2007
Accepted: February 08, 2008

Abstract

Silene L. is one of the major genera of the Turkey flora, with 170 species presently known from the area [%40 endemic]. It includes several polymorphic and taxonomically problematic species. Brachypodae sect. consist of three species, which is endemic in Turkey except *S. leptoclada*. These species were compared morphologically and karyologically. Morphologically, stems, shape of leaves, calyx, flowers, and fruit structure are examined and discussed. Some properties of the species haven't been defined systematically in Flora of Turkey. Therefore morphological study was done by investigeting undefined properties. A univariate morphometric study revealed some valuable quantitive characters useful for the identification of these species. Micromorphological features of seeds were investigated by SEM. The choromosome number of all these species was found to be 2n=24. Choromosome counts of three species are given for the first time. In this study, extensive descriptions of morphological and karyological characteristic of sect were investigated. A new key provided, as well as new and detailed descriptions.

Key words: Cytotaxonomy, morphology, phylogeny, taxonomy

INTRODUCTION

Silene L. is one of the largest plant genera in the world with c. 700 species, of which about half occur in the Mediterranean area to wich no less than 40 % of their total are endemic. The South Balkan Peninsula and South-west Asia are two of the main centres of diversity of the genus. [1]. *Silene* is one of the richest species in Turkey, having 31 sections which is represented by 170 species [2-4]. In the Flora of Turkey the reports of species were based on a few specimens [2]. This is account does not exactly reflect the variability of the populations. The genus has some systematic problems and a revision of the Turkish species is required. I believe that after revision, some new species will be added and some species will become synonymus with each other.

Here, we report the results of a study on three related species which are endemic (not *S. leptoclada*) areas in Anatolian Turkey. During the project 'Revisions of Sect. Brachpodae of Genus *Silene* L. in Turkey' carried out in 2004-2007. many more specimens were collected from type localities or nearby by OZCELİK and KILIC [5]. All these species, which occur in approximately the same region and show external resemblance, were comparatively investigated in terms of morphology and karyology. Such studies are important for the understanding and elucidation of taxonomic problems within species and within species groups.

MATERIALS AND METHODS

Species examined were collected either from the type locality or in its vicinity. Analyses of populations were made using 35 morphological characters (Table 1). Each value is the average of 20 mesurements from different specimens. Results were performed based on SPSS (version 10.0) program and a multible comparison test was performed the significance of differences ($P<0.05$). Our collections heve been placed in SDU. The morphological characters of the seeds were determined according to Prentice [6] and Stearn [7]. The taxonomic description of the species was widen according to Flora of Turkey [2]. Risk categories of taxa was determined according to IUCN [8, 9].

For the study of somatic choromosomes, root types were obtained from seeds germinated in Petri dishes. They were pretreated in α-monobromonaphthalene overnight and then fixed in ethanol:acetic acid (3:1). Roots were hydrolyzed in 1 N HCL at 60 ^{0}C for 10 min and stained in Feulgen. Squashes were made in 45 % acetic acid. Permanent slides were made in Depex. Choromosome measurements were based on five metaphase plates. Choromosomes were classified using the nomenclature of Levan et al [10].

Examined specimens are as follows:

Silene leptoclada **Boiss.**-Turkey C3 Antalya: Elmalı mountain, N 36^0 44' E 29^0 54', 1220-1245 m, 29.05.2005, Kılıç 82 (Topotype). C3 Antalya: Akseki, between Güzelsu-Sadıklar, 1250 m, 20.08.1995, A. Duran, GAZİ 3235. C3 Isparta: Aksu, above Pınargözü, 2100-2400 m, 24.08.1997, Ozcelik 7840.

C3 Antalya: Korkuteli, Garipçe village, 1400 m, 29.07.1997, Aytaç 7778. limestone rocks, slopes, rock crevices, cliffs, rocky slopes, screes.

***Silene inclinata* Hub.-Mor.**-B6 Kayseri: Pınarbaşı to Gürün, 1800 m, 01.07.2003, Kılıç & Ozçelik 42. B8 Erzurum: Erzincan-Erzurum road, N 39^0 50' E 40^0 34', 1900-2000 m, 02.07.2006, Ozçelik 12424, rock crevices, cliffs, slopes.

***Silene balansae* Boiss.**-B6 Kayseri: Binboğa mountain, Ziyaret hill N 38^0 25' E 36^0 33', 1950-2300 m, 14.07.2005, Kılıç & Ozcelik 679 (Topotype), rock crevices.

RESULTS

Morphological Characteristics

Morphological characters of *Silene* in Brachypodae Sect. are shown Table 1.

Cytotaxonomic Analysis

Analyses of somatic metaphase spreads of all the species examined in section Brachypodae are diploid with the choromosome number of 2n=24 (Figure 1-3).

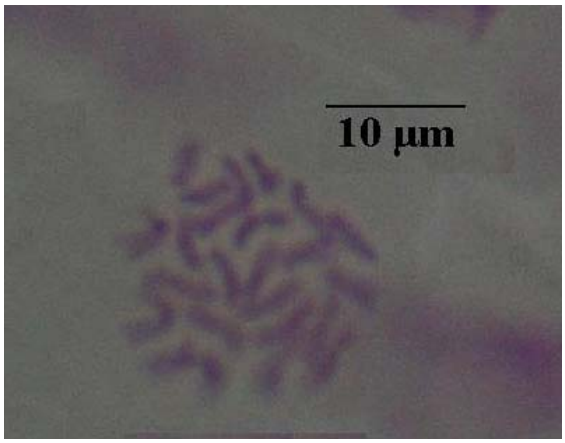

Figure 1. Mitotic metaphase chromosomes of S. leptoclada

All choromosome are metacentric in the three species except chromosome 5 and 8 in *S. leptoclada*, choromosome 6 in *S. inclinata* and choromosome 9, 10, 11. In *S. balansae*, where they are submetacentric. Choromosome counts and detailed karyotypic measurements for all three species are instesd given have for the first time. There is a slight difference in the total lengths and arm ratio of choromosomes. Arm ratios in metacentric choromosomes range from 1.04 to 1.92. In submetacentric choromosomes, arm ratios are from 1.85 to 2.22. the total length of haploid complement is similar in *S. leptoclada* and *S. inclinata*; 37.3 µm, 42.51 µm, respectively. owever, total haploid length in *S. balansae* is quite bigger than in the other species, 55.9 µm (Table 2).

Table 1. Comparison of morphological characters of *Silene* in Brachypodae Sect.

Characters	S. leptoclada	S. inclinata	S. balansae
Height of plant (cm)	*26.45±5.01^a,	31.54±4.76^b,	48.90±10.34^c,
Stem hairs	densely eglandular-pubescent	sparsely eglandular-pubescent	glabrous from at the base up to the middle part of stem, above of stem glandular-pubescent
Bazal leaves (mm)	28.8±8.68 x 4,75±1,54^b	30.58±7.66 x 2.39±0.71^a	44.24±7.21 x 6.02±2.38^b
Shape of bazal leaves	oblanceolate,	lanceolate,	elliptic-spathulate,
Cauline leaves (mm)	16.62±5.01 x 2,83±0,91^a	20.83±4.82 x 2.02±0.41^b	37.70±10.48 x 3.5±0.95^c
Shape of cauline leaves	narrowly elliptic,	lanceolate,	linear-lanceolate,
Hairs of all leaves	sparsely eglandular-sericeous	eglandular-canescent	eglandular-serisceous
Inflorescence	1-2 or 3 flowered dichasium	compound dichasium	strict panicle
Pedincule (mm)	38.92±10.71^a	64.98±10.69^b	99.30±22.92^c
Hairs of pedincule	glandular-puberulous	eglandular-canescent	glandular, sericeous
Pedicels (mm)	14.11±5.96^c	2.94±0.7^a	7.83±1.53^b
Hairs of pedicels	sparsely glandular-puberulous	eglandular-canescent	glabrous
Calyx (mm)	12.01±1.01^a	13.09±1.04^b	13.70±1.74^c
Hairs of calyx	sparsely glandular-puberulous,	eglandular-puberulous,	glabrous,
Vein of calyx	reticulately	parallel	parallel
Petals (mm)	pinkish, 13.76±1.47^a, bifid	yellowish, 13.71±1.13^a, deeply bifid	deep pink, 13.53±1.28^a, deeply bifid
Styles	hairy	glabrous	glabrous
Capsule (mm)	9.67±1.10^b, included in the calyx	08.37±0.94^a, included in the calyx	10.17±1.26^b, slightly exerted from the calyx
Anthophore (mm)	2.96±0.30^a	3.36±0.28^b	4.24±0.85^c
Hairs of anthophore	glabrous	eglandular-pubescent	glabrous
Seeds (mm)	0.69±0.17x0.49±0.12^a, bright brown	0.74±0.15x0.51±0.14^a, dark brown	1.78±0.38x1.49±0.4^b, brown
Habitat (m)	slopes, rocky places 400-3000	slopes, rocky places, 1700-1800	rocky places 1900-2300
Risk categories	NT	CR	EN

*Shows values with significant difference (<0,05) for each column shown with the same letters

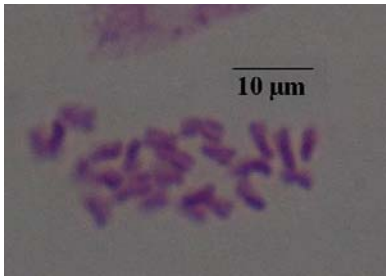

Figure 2. Mitotic metaphase chromosomes of *S. inclinata*

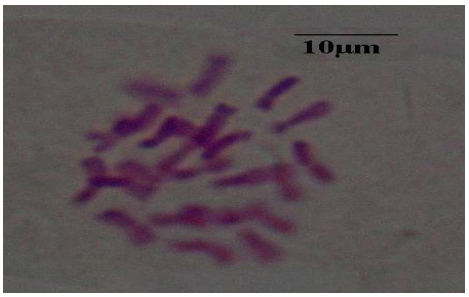

Figure 3. Mitotic metaphase chromosomes of S. balansae

Table 2. The detailed features of these somatic metaphase choromosomes of *Silene* in Brachypodae sect.

Chromosome Pairs	Total length (µm)	Choromosome arms (µm)		Arm ratio (L/S)	Relative length (%)	Chromosome type
		long arm (L)	Short arm (S)			
S. leptoclada Boiss.						
I	3.98±0.11	2.16	1.82	1.18	18.74	m
II	3.58±0.10	2.06	1.52	1.35	20.83	m
III	3.49±0.16	1.95	1.54	1.26	21.37	m
IV	3.42±0.12	1.82	1.60	1.13	21.81	m
V	3.32±0.75	2.29	1.03	2.22	22.46	sm
VI	3.25±0.88	1.66	1.59	1.04	22.95	m
VII	3.04±0.15	1.73	1.38	1.25	24.53	m
VIII	2.97±0.12	1.93	1.04	1.85	25.11	sm
IX	2.87±0.12	1.56	1.31	1.19	25.99	m
X	2.74±0.13	1.61	1.13	1.42	27.22	m
XI	2.43±0.05	1.41	1.02	1.38	30.69	m
XII	2.21±0.07	1.38	0.83	1.66	33.75	m
Total length of haploid complement 37.3 µm						
S. inclinata Hub.-Mor.						
I	4.68±0.45	2.54	2.13	1.20	18.19	m
II	4.11±0.32	2.34	1.77	1.31	20.67	m
III	4.12±0.06	2.43	1.38	1.47	20.60	m
IV	3.97±0.52	2.31	1.66	1.39	21.43	m
V	3.74±0.75	2.04	1.70	1.19	22.70	m
VI	3.62±0.54	2.36	1.25	1.88	23.48	sm
VII	3.43±0.15	1.92	1.50	1.27	24.78	m
VIII	3.29±0.13	2.06	1.23	1.68	25.85	m
IX	3.17±0.13	1.93	1.24	1.55	26.75	m
X	2.98±0.25	1.80	1.18	1.52	28.58	m
XI	2.82±0.23	1.74	1.07	1.64	30.34	m
XII	2.58±0.38	1.52	1.06	1.45	32.96	m
Total length of haploid complement 42.51 µm						
S. balansae Boiss.						
I	6.00±0.05	3.46	2.54	1.37	18.63	m
II	5.44±0.78	3.33	2.11	1.58	20.56	m
III	5.19±0.36	2.95	2.24	1.31	21.53	m
IV	5.06±0.42	2.93	2.13	1.40	22.08	m
V	4.92±0.35	2.96	1.95	1.57	22.76	m
VI	4.74±0.03	2.95	2.04	1.70	23.64	m
VII	4.62±0.13	2.74	1.88	1.47	24.37	m
VIII	4.50±0.18	2.82	1.67	1.68	24.21	m
IX	4.30±0.49	2.73	1.56	1.80	26.03	sm
X	4.11±0.75	2.65	1.45	1.92	26.24	sm
XI	3.73±0.04	2.41	1.32	1.85	30.11	sm
XII	3.29±0.16	2.01	1.28	1.62	34.00	m
Total length of haploid complement 55.9 µm						

DISCUSSION

Some morphological characters of the above mentioned species have not been defined by Flora of Turkey. In this work, the morphological characters of the species were obtained and also their description were widen.

The morphologic characters of specimens were according to differences in their kantitatif ($P<0.05$) and kalitatif characters (Table 1). These differences are used easily distinguish species in Brachypodae sect.

Characteristics of Brachypodae sect.; Stems 10-75 cm; nodes slightly swollen; internodes 1-3 cm long below, up to 8 cm long above. Bazal leaves elliptic-spathulate, lanceolate, oblanceolate; 15-60 x 1.5-11 mm; cauline leaves linear-lanceolate, elliptic; 3-45 x 0.5-5 mm; all leaves serisceous, canescent. Bracts lanceolate; 1.1-30 x 0.4-1.8 mm. Pedincule 17-150 mm; glandular, eglandular, glabrous; pedicels 1-38 mm; glandular, eglandular, glabrous. Inflorescence dichasium or strict panicle. Calyx tubular; 8-17 mm; somewhat inflated, but sharply constricted around the base of the capsule in fruit; 10-nerved, or sometimes obscured, reticulately, düzgün veined; glabrous or pubescent; calyx teeth 0.5-2.5 x 0.5-2.8 mm; 1.2-4 mm apex size in flowers; 1.8-5.1 mm apex size in fruit. Petals bifid; pinkish, yellowish; 8.5-17 mm, 1.2-5.5 mm longer than calyx, limb 3-7.5 mm; limb divided to about ½ of its length, lobes recurved; coronal scales presents, c. 1.5 mm long; claw 3.4-12.5 mm; glabrous. Pistil 5-9.5 mm; styles 3; homostyles; styles hairy or glabrous; 2-5.4 mm; ovaryum 3.4-7.1 x 0.6-3.2 mm. Stamens 10 (5 long, 5 short); long stamens 3.4-9 mm; short stamens 1.8-7.3 mm; anthers 0.5-1.2 x 0.2-0.7 mm. Anthophore 2-6 mm. Capsule oblong, exerted slightly from the calyx; 6.8-12.5 x 2.2-7 mm; capsule teeth triangular; 1-3 x 0.5-2.5 mm; apex size 1.5-4.8 mm. Seeds reniform; bright or dark brown; 0.4-2.2 x 0.2-1.9 mm (Figure 4-6).

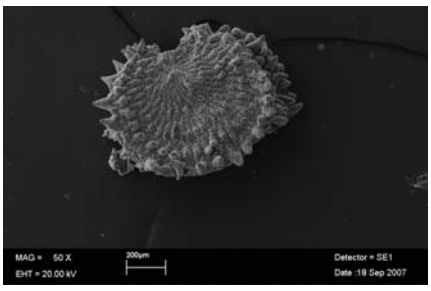

Figure 4. Seed of *S. leptoclada*

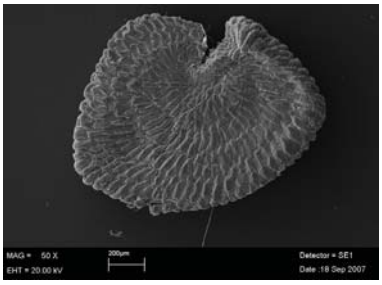

Figure 5. Seed of *S. inclinata*

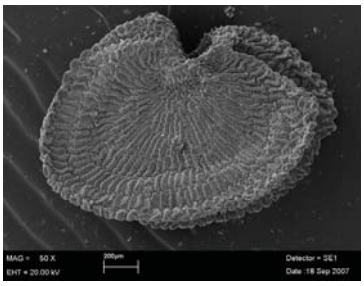

Figure 6. Seed of *S. balansae*

Coode and Cullen [2] observed that diagnostic of Brachypodae sections was inflorescense compound dichasium, calyx hairy, petals bifid. The results we obtained in this study are consistent with their findings except inflorescense and calyx surface. Whereas, we determined that inflorescense 1-2 or 3 flowered; calyx glabrous, pubescent (Table 1). On the other hand, Greuter [1] reported that the morphology of Brachypodae sect., localite in Greece, was stems eglandular, glandular; leaves linear, spathulat; inflorescense solitary (rarely 2-flowered), simple or compound dichasium; calyx pubescent; anthophore pubescent, glabrous and this complies with findings (Table 1). Our morphologic findings interesting in *S. balansae* support Vural and Adıgüzel [11], which is calyx 11-16 mm, glabrous, 10 vein; calyx teeth triangular; petals yellowish-green, 18 mm, deeply bifid; anthophore 6 mm; glabrous; capsule 8 mm (Table 1). Coode and Cullen [2] stated that a endemic species of *S. leptoclada*. However, our findings demostrated that this species was not endemic in Turkey. Its locality was determined that SW Anatolia and Kastellorizo (Grek) [1].

Key to morphologic of species Silene sect. Brachypodae

1. Calyx ve pedicels hairy, all of stem hairy

2. Anthophore glabrous, calyx sparsely glandular – puberulous, pedicels glandular, calyx teeth acuminate ……. S. leptoclada

2. Anthophore pubescent hairy, calyx eglandular – canescent, pedicels eglandular, calyx teeth triangular …..……..……...S. inclinata

1. Calyx ve pedicels glabrous, glabrous from at the base up to the middle part of stem, above of stem glandular-pubescent ……..……....S. balansae

This interpretation difference leads to sinonimization and the transference of several species to closely related genera. The cytotaxonomic study of species of Silene L. was made aiming at increase of knowledge of chromosome characteristics that could be useful to the understanding of the taxonomy of the group as a whole. Nevertheless, the available data indicate only a tenuous relationship between the chromosome numbers observed here and reported in the literature compared to the taxonomic reorganization.

The taxonomy of Silene Sect. Brachypodae is evidently complicated. morphological differentiation is rather weak, and it appears that other sources of systematic evidence, such as palynology and cytology, can provide rather limited additional information at the specific level. However, in this study we observed that these species which are similar in their external

morphology, can be distinguished from each other by their karyological characteristics.

Consequently, this study may serve to compose section key of Silene genus.

Acknowledgements

The authors thank the Scientific and Tecnological Research Council of Turkey (TUBITAK) for financial support by the projects TBAG 2406 (104T016).

REFERENCES

[1] Greuter, W. 1995. *Silene* (Caryophyllaceae) in Greece: a subgeneric and sectional classification. Taxon 44: 543-581.

[2] Coode. M.J.E. and Cullen. J.. 1967. Silene L. In Flora of Turkey and the East Aegean Islands (ed. Davis PH). Vol. 2. pp. 179-242. Edinburgh Univ. Pres.

[3] Davis, PH; Mill, RR; Tan, K. 1988. *Silene* l. In: Davis PH; Mill RR; Tan, K. eds. Flora of Turkey and the East Aegean Islands, Vol. 10 (suppl.) Edinburgh: Edinburgh University Press, 76-81.

[4] Tan, K. and Vural, M. 2000. *Silene* L. In: Güner, A., Özhatay, N., Ekim, T., Başer, KHC, eds. Flora of Turkey and the East Aegean Islands, Vol. 11 (Suppl.) Edinburgh; Edinburgh University Press, 50-53.

[5] Ozcelik, H. and Kılıc, S., 2004. Türkiye'nin *Silene* L. (Caryophyllaceae) Cinsi Brachypodae Boiss. ve Auriculatae Boiss. Seksiyonlarının Revizyonu. TBAG 2406 (104T016). TÜBİTAK.

[6] Prentice H.C. 1978. Experimental taxonomy of Silene section Elisanthe (Caryophyllaceae): Crossing experiments Botanical Journal Linnaen Society. 77: 203-213.

[7] Stearn. W.T. 1996. Botanical Latin. 4 th. ed.. pp. 489-491. London: David & Charles.

[8] Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z., Adıgüzel, N., 2000. Türkiye Bitkileri Kırmızı Kitabı. Türkiye Tabiatını Koruma Derneği, Van Yüzüncü Yıl Üniversitesi Yayınları, Yayın No:18, Ankara.

[9] IUCN, Species Survival Commision, 2001. IUCN Red List Categories: Version 3.1. Gland, Switzerland and Cambridge, UK: IUCN.

[10] Levan. A., Fredga. K. and Sandberg. A.A.. 1964. Nomenculature for centromic position on chromosomes. Hereditas. 52: 201-220.

[11] Vural, M., Adıgüzel, N., 1996. Türkiye Florasıyla İlgili Notlar II-*Silene eserei*, *Aconiopsis*, *Silene argaea* ve *Silene balansae* (Caryophyllaceae). Ot Sistematik Botanik Dergisi, 3: 2, 93-98.