

KARYOTYPE ANALYSIS OF SOME *LILIUM* L. (*LILIACEAE*) SPECIES FROM TURKEY

HÜSEYİN INCEER, OSMAN BEYAZOĞLU AND SEMA HAYIRLIOĞLU-AYAZ

*Karadeniz Technical University, Faculty of Sciences and
Arts, Department of Biology, 61080 Trabzon, Turkey*

Abstract

Karyotype analysis of four *Lilium* L. (*Liliaceae*) species viz., *L. candidum* L., *L. martagon* L., *L. ciliatum* P.H. Davis and *L. carniolicum* subsp. *ponticum*. (C.Koch) Davis & Henderson distributed in North East Anatolia, Turkey, was carried out. The chromosome number was found to be $2n = 24$ in all taxa. The karyotype analysis showed that the karyotypes of these taxa consist of median, submedian, subterminal and terminal chromosomes.

Introduction

The genus *Lilium* L. (*Liliaceae*) includes up to 100 species widely distributed across Temperate Asia, Europe and North America (Synge, 1980). According to the records in the Flora of Turkey, the genus is represented by 5 species, 1 subspecies and 4 varieties. Most of the species of this genus are distributed in North Anatolia (Davis, 1984).

The genus *Lilium* includes many beautiful ornamental species. Their cultivars are derived from intra as well as interspecific hybridization and are now widely cultivated in the world. The consumption of flowers and environmental plants has recently increased considerably triggering demand for novel types of flowers in lilies as well. For the production of such novel cultivars, interspecific hybridization is expected to be one of the most useful means (Mii *et al.*, 1994). *Lilium* species are important for their economic value. The genus has been studied for its chemical properties (Zeybek, 1994). Because different species have saponin glikoside, they are used in the treatment of skin diseases (Baytop, 1984).

Many karyological studies have been undertaken on *Lilium* species by several authors (Stewart, 1947, Lighy, 1960; Smyth; *et al.*, 1989). Smyth *et al.*, (1989) expressed C-band patterns in twenty *Lilium* species. No reports are available on the chromosome number and morphology of *Lilium* L., species distributed in Turkey. The present studies dealing with karyotype analyses were undertaken involving 3 species and 1 subspecies of *Lilium* from different localities.

Materials and Methods

Lilium candidum L., *Lilium martagon* L., *Lilium ciliatum* P.H. Davis and *Lilium carniolicum* subsp. *ponticum* (C. Koch) Davis & Henderson were used in this study. They were collected from the mountains of Northeast Anatolia, Turkey, between June and July in 1996 and 1997.

Table 1. Chromosome types, chromosome length and arm ratio of *Lilium candidum*.

Chromosome pairs	C (μm)	L (μm)	S (μm)	L/S	SAT (μm)	I (μm)	R	C.V. %	Centromere position
1	13.02 \pm 1.52*	6.85	6.17	1.11	1.46	47.38	11.45	11.67	median region
2	11.87 \pm 2.33	8.0	3.87	2.06	-	32.60	10.43	19.62	submedian region
3	11.01 \pm 1.71	10.08	0.93	10.83	-	8.44	9.68	15.53	terminal region
4	10.36 \pm 1.69	9.40	0.96	9.79	-	9.26	9.11	16.31	terminal region
5	10.04 \pm 1.36	9.15	0.89	10.28	-	8.86	8.83	13.54	terminal region
6	9.61 \pm 1.29	7.82	1.79	4.36	-	18.62	8.45	13.42	subterminal region
7	9.20 \pm 0.90	8.35	0.85	9.82	-	9.23	8.09	9.78	terminal region
8	9.13 \pm 1.01	7.65	1.48	5.16	-	16.21	8.02	11.06	subterminal region
9	8.71 \pm 1.29	7.71	1.0	7.71	-	11.48	7.66	14.81	terminal region
10	8.07 \pm 0.94	8.07	-	-	-	-	7.09	11.64	terminal point
11	7.16 \pm 0.72	5.94	1.22	4.86	2.48	17.03	6.29	10.05	subterminal region
12	5.52 \pm 0.86	4.31	1.21	3.56	2.22	21.92	4.85	15.57	subterminal region

C: Total chromosome length, L: Long arm length, S: Short arm length, L/S: Arm ratio, SAT: Satellite, I: Centromere index, R: Relative length, C.V. %: Coefficients of variability.

* Standard deviations.

Table 2. Chromosome types, chromosome length and arm ratio of *Lilium martagon*.

Chromosome pairs	C (μm)	L (μm)	S (μm)	L/S	SAT (μm)	I (μm)	R	C.V. %	Centromere position
1	19.97 \pm 1.74	11.57	8.40	1.37	-	42.06	12.78	8.71	median region
2	17.59 \pm 1.17	11.13	6.46	1.72	-	36.72	11.26	6.65	submedian region
3	14.65 \pm 1.24	13.36	1.29	10.35	-	8.80	9.37	8.46	terminal region
4	14.05 \pm 1.14	12.71	1.34	9.48	-	9.53	8.99	8.11	terminal region
5	13.18 \pm 1.06	11.74	1.44	8.15	-	10.92	8.43	8.04	terminal region
6	12.69 \pm 0.57	11.25	1.44	7.81	-	11.34	8.12	4.49	terminal region
7	11.95 \pm 0.66	10.34	1.61	6.42	-	13.47	7.64	5.52	subterminal region
8	11.34 \pm 0.63	9.55	1.79	5.33	-	15.78	7.25	5.55	subterminal region
9	10.98 \pm 0.66	10.23	0.75	13.64	-	6.83	7.02	6.01	terminal region
10	10.44 \pm 0.57	9.37	1.07	8.75	-	10.24	6.68	5.45	terminal region
11	10.06 \pm 0.69	8.45	1.61	5.24	-	16.00	6.44	6.85	subterminal region
12	9.31 \pm 0.99	8.45	0.86	9.82	-	9.23	5.95	10.63	terminal region

Actively growing root tips were used for karyotype analyses and chromosome counts. For this purpose, the root tips were cut off and pre-treated with 0.05% colchicine for 3-4 h and then fixed in an ethanol - acetic acid (3:1) solution for at least 24 h at 4°C (Hayirlioglu & Beyazoglu, 1997). The root tips were hydrolyzed in 1 N HCl at 60°C for 12-13 min., and then rinsed with tap water for a minimum of 2-3 min. Staining was carried out in Feulgen for 1.5 h. Karyotype analysis was performed according to Levan *et al.*, (1965). Photomicrographs were taken from at least five well-spread metaphase plates using an Olympus BH-2 camera. Permanent slides were deposited in the Department of Biology, Karadeniz Technical University, Trabzon.

Results

Chromosome number and morphology of the species examined is as follows:

L. candidum L.: Chromosome number is $2n = 24$. The 1st chromosome is median and the 2nd is submedian-centromeric. The 6th, 8th, 11th and 12th chromosomes are subterminal, the 3rd, 4th, 5th, 7th and 9th have terminal centromeres. The 10th chromosome has terminal point centromere. The satellites are present on the short arms of the 1st, 11th and 12th chromosomes (Table 1, Fig. 1a & 2A).

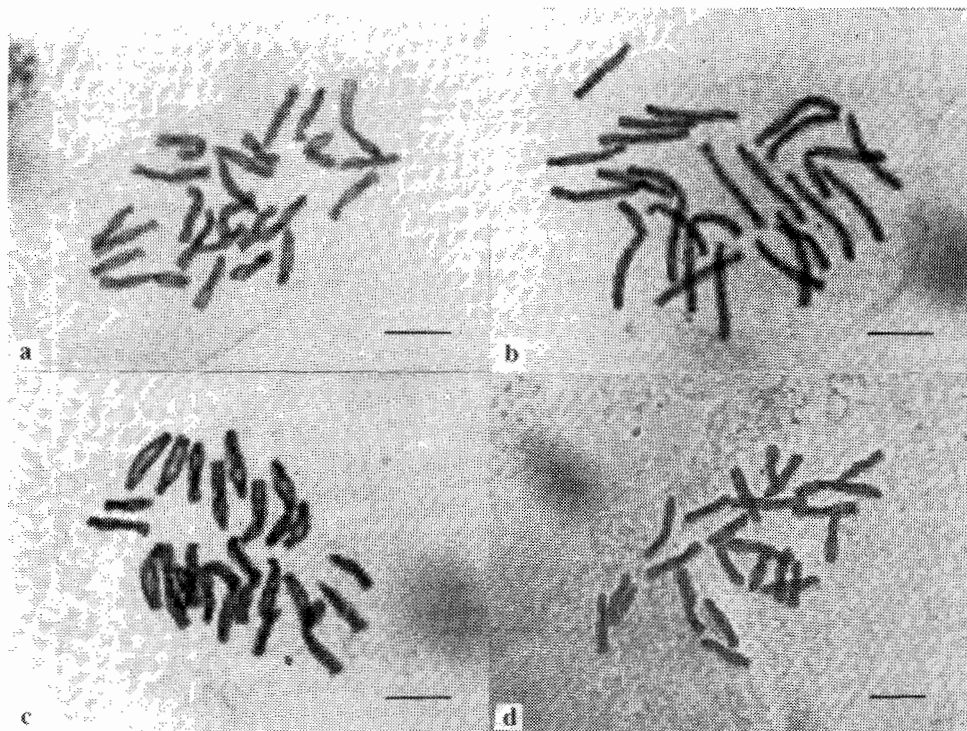


Fig.1. Mitotic metaphase chromosomes in *Lilium* L.

A) *L. candidum*, B) *L. martagon*, C) *L. ciliatum*, D) *L. carniolicum* subsp. *ponticum*. Bar: 10 μ m.

Table 3. Chromosome types, chromosome length and arm ratio of *Lilium ciliatum*.

Chromosome pairs	C (μm)	L (μm)	S (μm)	L/S	SAT (μm)	I (μm)	R	C.V. %	Centromere position
1	13.70 \pm 0.86	7.86	5.84	1.34	-	42.62	12.08	6.27	median region
2	12.55 \pm 0.11	8.37	4.18	2.00	-	33.30	11.06	5.65	submedian region
3	10.94 \pm 0.43	9.94	1.0	9.94	-	9.14	9.64	3.93	terminal region
4	10.40 \pm 0.78	9.40	1.0	9.40	-	9.61	9.17	7.5	terminal region
5	9.97 \pm 0.66	8.97	1.0	8.97	-	10.03	8.79	6.61	terminal region
6	9.60 \pm 0.50	8.62	0.98	8.79	-	10.20	8.46	5.20	terminal region
7	8.74 \pm 0.76	7.28	1.46	4.98	-	16.70	7.70	8.69	subterminal region
8	8.28 \pm 0.50	6.89	1.39	4.95	-	16.78	7.30	6.03	subterminal region
9	8.07 \pm 0.62	8.07	-	-	-	-	7.11	7.68	terminal point
10	7.16 \pm 0.48	5.78	1.38	4.18	1.14	19.27	6.31	6.70	subterminal region
11	7.02 \pm 0.52	5.56	1.46	3.80	1.64	20.79	6.19	7.40	subterminal region
12	6.95 \pm 0.66	5.74	1.21	4.74	-	17.41	6.12	9.46	subterminal region

Table 4. Chromosome types, chromosome length and arm ratio of *Lilium carnolicum* subsp. *ponticum*.

Chromosome pairs	C (μm)	L (μm)	S (μm)	L/S	SAT (μm)	I (μm)	R	C.V. %	Centromere position
1	15.07 \pm 0.90	8.77	6.30	1.39	-	41.80	11.66	5.29	median region
2	13.85 \pm 0.94	9.11	4.74	1.92	-	34.22	10.72	5.66	submedian region
3	12.05 \pm 0.76	10.83	1.22	8.87	-	10.12	9.33	5.30	terminal region
4	11.35 \pm 0.50	10.44	0.91	11.47	-	8.01	8.78	3.63	terminal region
5	10.76 \pm 0.72	9.17	1.59	5.76	-	14.77	8.33	5.50	subterminal region
6	10.66 \pm 0.72	9.75	0.91	10.71	-	8.53	8.25	5.61	terminal region
7	10.45 \pm 0.80	9.78	0.67	14.59	-	6.41	8.09	6.44	terminal region
8	9.69 \pm 0.50	8.83	0.86	10.26	-	8.87	7.50	4.25	terminal region
9	9.47 \pm 0.38	7.86	1.61	4.88	-	17.00	7.33	3.33	subterminal region
10	9.03 \pm 0.52	7.50	1.53	4.90	-	16.94	6.99	4.87	subterminal region
11	8.54 \pm 0.50	6.95	1.59	4.37	-	18.61	6.61	5.26	subterminal region
12	8.23 \pm 0.75	7.62	0.61	12.49	-	7.41	6.37	7.69	terminal region

L. martagon L.: Chromosome number is $2n = 24$. The 1st chromosome is median and the 2nd is submedian-centromeric. The 7th, 8th, and 11th chromosomes are subterminal, the 3rd, 4th, 5th, 6th, 9th, 10th and 12th are terminal-centromeric. No satellite was observed in this species (Table 2, Fig. 1b & 2B).

L. ciliatum P.H. Davis: Chromosome number is $2n = 24$. The 1st chromosome is median and 2nd is submedian-centromeric. The 7th, 8th, 10th, 11th and 12th chromosomes are subterminal and 3rd, 4th, 5th and 6th chromosomes are terminal-centromeric. The 9th chromosome is terminal point centromeric. The satellites are present on the short arms of the 10th and 11th chromosomes (Table 3, Fig. 1C & 2C).

Lilium carniolicum subsp. *ponticum* (C. Koch) Davis & Henderson: Chromosome number is $2n = 24$. The 1st chromosome is median and 2nd is submedian-centromeric. The 5th, 9th, 10th and 11th chromosomes are subterminal and 3rd, 4th, 6th, 7th, 8th and 12th chromosomes are terminal-centromeric. No satellite is present on the karyotype of this species (Table 4, Fig. 1d & 2D).

Discussion

All taxa investigated are diploid with $2n = 24$ chromosomes. The karyotypes of these species consist of median, submedian, subterminal and terminal chromosomes (Fig. 2). These findings agree with reports of chromosome number and karyotype for other species of *Lilium* (Stewart, 1947; Lighty, 1960). Asano, (1983) reported that the chromosome complement of diploid hybrid species in *Lilium* usually consists of two pairs of larger submedian and 10 pairs of subterminal chromosomes. According to Smyth *et al.*, (1989), 20 species of *Lilium* have a similar basic karyotype and the chromosome number of these taxa is $2n = 24$.

Stewart (1947) found that the chromosome number of *L. candidum* and *L. martagon* is $2n = 24$ and the karyotypes of these species consist of two pairs of median-centromeric and ten pairs terminal-centromeric chromosomes. In the present study we found that the karyotype of *L. martagon* consists of one pair of centromeres in the median position, one pair in the submedian, three pairs of in the subterminal and seven pairs of in the terminal position. *L. candidum* has one pair of median-centromeric, one pair of subterminal-centromeric, four pairs of subterminal-centromeric and six pairs of terminal-centromeric chromosomes (Fig. 2).

The chromosome number and morphology of *L. ciliatum*, which is endemic to Turkey, and *L. carniolicum* subsp. *ponticum* are being reported for the first time. According to our observations these species have $2n = 24$ chromosomes, and in both the species the chromosomes are median, submedian, subterminal and terminal centromeric.

Stewart (1947) and Smyth *et al.*, (1989) also noted that the karyotypes of *L. candidum* and *L. martagon* are secondary constriction (NOR). Stewart (1947) reported four NORs in *L. martagon*. For this species, Smyth *et al.*, (1989) found five NORs. Stewart (1947) and Smyth *et al.*, (1989) identified three NORs in *L. candidum* but we could not clearly see secondary constriction in each species.

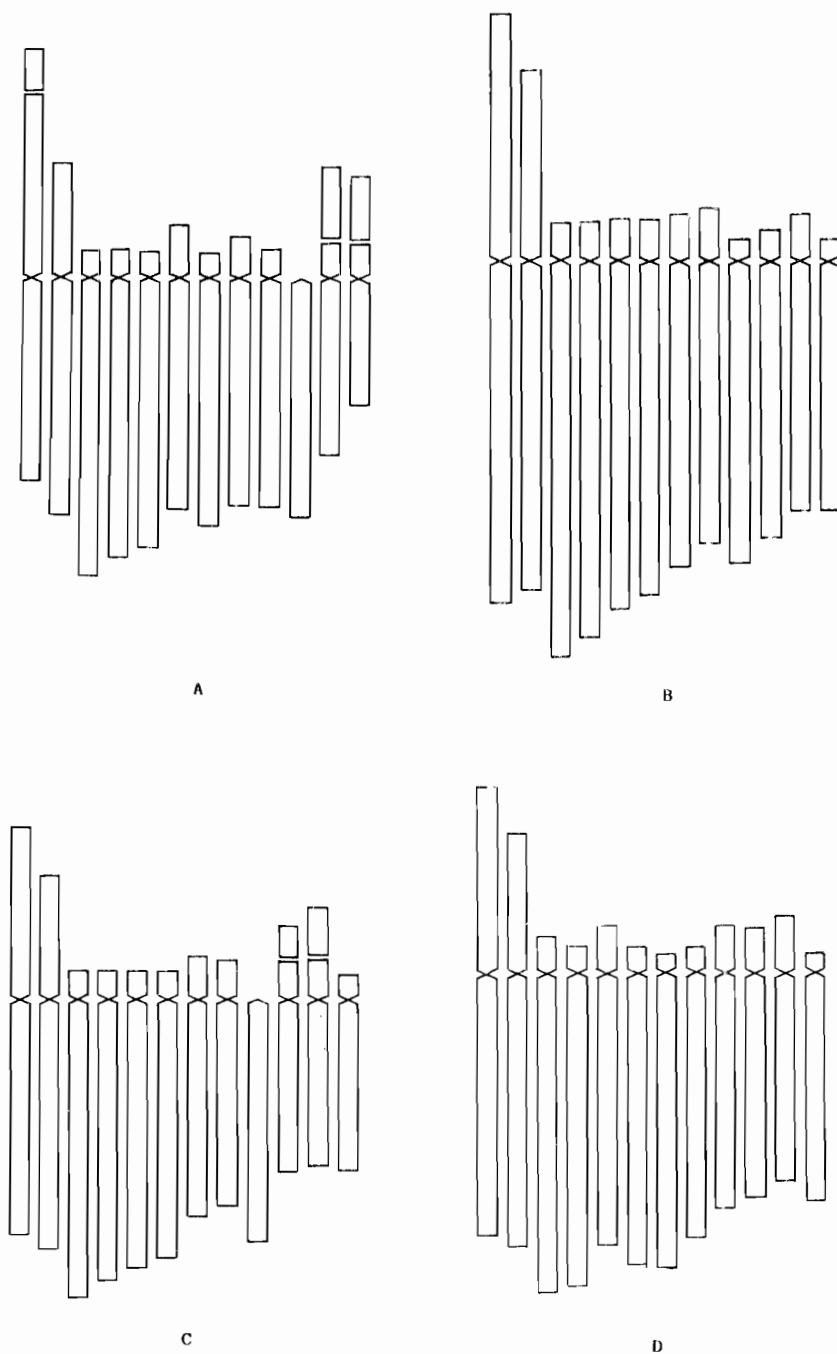


Fig.2. Idiograms of the chromosome complement of four *Lilium* L. species at mitotic metaphase.
A) *L. candidum*, B) *L. martagon*, C) *L. ciliatum*, D) *L. carniolicum* subsp. *ponticum*.

The present study indicates that all taxa have similar chromosome complements. The karyotype of *L. candidum* is similar to that of *L. ciliatum*. No satellite is present on the karyotype of these taxa. Similarly, the karyotype of *L. martagon* and *L. carniolicum* subsp. *ponticum* are also similar. These karyotypes are in good agreement with the systematic relationships of investigating taxa within the genus *Lilium*. Besides, the karyotype characteristics of these species could be correlated with the external morphological characteristics.

References

- Asano, Y. 1983. Random distribution of the number of chromosome pairings in interspecific hybrids of *Lilium*. *Cytologia*, 48:803-809.
- Baytop, T. 1984. *Türkiye'de Bitkiler ile Tedavi*. Istanbul Üniversitesi Yayınları, Istanbul.
- Davis, P.H. 1984. *Flora of Turkey and The East Aegean Islands*. Edinburgh University Press, Edinburgh, 8: 279-284.
- Hayirlioglu, S. and O. Beyazoglu. 1997. Chromosome numbers in species of *Alchemilla* L., belong to the series *Sericeae* Bus. and *Pubescentes* Bus., (section *Alchemilla* Rothm.) in Turkey. *Caryologia*, 50:77-84.
- Levan, A., K. Fredga and A. Sandberg. 1965. Nomenclature for centromeric position on chromosomes. *Hereditas*, 52:201-220.
- Lighty, R. W. 1960. *Cytological and Interspecific hybridization studies in Lilium L., and Their Significance for Classification*. Ph. D. Thesis. Cornell University.
- Mii, M., Y. Yuzawa, H. Suetoni, T. Motegi and T. Godo. 1994. Fertile plant regeneration from protoplasts of a seed-propagated cultivar of *Lilium* x *formolongi* by utilizing meristematic nodular cell clumps. *Plant Science*, 100: 221-226.
- Stewart, R.N. 1947. The morphology of somatic chromosomes in *Lilium*. *Amer. J. Bot.*, 34:9-26.
- Smyth, D.R., K. Kongsuwan and S. Wisudharomn. 1989. A survey of c-band patterns in chromosomes of *Lilium* (*Liliaceae*). *Pl. Syst. Evol.*, 163:53-69.
- Synge, P.M. 1980. *Lilies*. London: Batysford.
- Zeybek, N. and U. ve Zeybek. 1994. *Farmasötik Botanik Kapalı Tohumlu Bitkiler (Angiospermae) Sistematigi ve Önemli Maddeleri*. Ege Üniversitesi Eczacılık Fakültesi Yayınları. No. 2. Ege Üniv. Basımevi. Bornova.

(Received for publication 2 June 1998)