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Research Article

Karyotype Analysis of *Dianthus muglensis* (Caryophyllaceae, Sileneae)

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Abstract

The majority of the family Caryophyllaceae has about 2100 species classified in 80 genera, which are distributed in the northern hemisphere. The genus *Dianthus*, which has more than 300 species, is the second-largest genus of the family Caryophyllaceae. The karyological parameters such as chromosome numbers (basic and diploid), chromosome size, and karyotype asymmetry are important characters in plant cytotaxonomy. In many species of the genus *Dianthus*, the basic and diploid numbers are $x = 15$ and $2n = 30$, respectively. The study aims to determine the chromosome number of *Dianthus muglensis* and to reveal the karyotype, ideogram, karyotype asymmetry and other detailed measurements. The chromosome number and karyotype formula are $2n = 30$ and 20m + 10sm, respectively. The chromosome number of *Dianthus muglensis* was recorded here for the first time. The chromosome lengths range between 1.02 and 2.65 µm. Chromosome arm ratio, relative length and centromeric index are ranging from 1.03 to 2.29, 6.22 to 10.56, and 30.39 to 49.37, respectively. According to intrachromosomal and interchromosomal asymmetry values, *Dianthus muglensis* has a symmetrical karyotype. Since symmetrical karyotypes are generally seen in the early stages of karyotype evolution, *Dianthus muglensis* can be considered to be involved in the early stages of karyotype evolution. In addition, listed data have made important contributions to the cytotaxonomy of genus *Dianthus*: (i) basic number of $x = 15$, (ii) diploid number of $2n = 30$, (iii) new karyotype formula of 20m + 10sm (iv) ploidy level of $2x$, and (v) symmetrical karyotype.

Keywords: *Dianthus*, Fimbriati, Chromosome, Cytotaxonomy

1. INTRODUCTION

The majority of the family Caryophyllaceae has about 2100 species classified in 80 genera, which are distributed in the northern hemisphere. Some varieties of the family show spread in the southern hemisphere. The Mediterranean phytogeographical region is the region where species are most widely distributed. The genus *Dianthus* L., which has more than 300 species, is the second largest genus of the family after the genus *Silene* L. [1–4].

In the genus *Dianthus*, there are both annual and perennial species. The *Dianthus* species are distributed in five sections, which are *Fimbriati* Boiss., *Carthusiani* Boiss., *Verruculosi* Boiss., *Dentati* Boiss., and *Leiopetali* Boiss. The species *Dianthus muglensis* Hamzaoğlu & Koç is located in the section *Fimbriati* [1]. Section *Fimbriati* is characterized by the fimbriate petals and distinguished from other sections by this feature [2].

The karyological parameters such as chromosome numbers (basic and diploid), chromosome size, and karyotype asymmetry are important characters in plant cytotaxonomy. In many species of genus *Dianthus*, the basic and diploid numbers are $x = 15$ and $2n = 30$, respectively [2,3,5,6]. In section *Fimbriati*, the diploid chromosome numbers were recorded from seven taxa. Six taxa are only diploid with $2n = 2x = 30$ [2,7–9]. *Dianthus crinitus* Sm. is diploid ($2n = 2x = 30$) and polyploid, which reveals only one polyploidy level of tetraploidy ($2n = 4x = 60$) [10]. The dominant chromosome number of the section *Fimbriati* is $2n = 30$. This study aims to determine the chromosome number of *Dianthus muglensis* and to reveal the karyotype, ideogram, karyotype asymmetry and other detailed measurements of the species.

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2. MATERIAL AND METHODS

2.1 Plant Material

Plant samples were collected and identified from their natural distribution areas by Prof. Dr. Ergin Hamzaoğlu and Prof. Dr. Murat Koç. Collection information of *Dianthus muglensis* is given below. The specimens were deposited at the herbarium of the Gazi University in Ankara.

Dianthus muglensis Hamzaoğlu & Koç: Endemic. Turkey. Muğla: Fethiye, between Ölüdeniz and Uzunyurt villages, roadside, above Kelebekler Valley, 425 m a.s.l., 20 October 2012, rock crevices, Hamzaoğlu 6681, Koç & Budak (GAZİ).

2.2 Cytogenetic Procedure

The cytological experiments were made on root tips. Root tips were obtained by germinating seeds on wet filter papers in petri dishes. The next steps were as follows. The first is the pretreatment step and root tips were treated with α-monobromonaphthalene at 4 °C for 16 hours. The second is the fixation step and root tips were treated with a fixative solution (absolute alcohol: glacial acetic acid, 3:1) at room temperature for 24 hours. The third is the hydrolysis step and root tips were treated with 1N HCl for 12 min. The fourth is the staining step and root tips were treated with 2% aceto-orcein at room temperature for 2 hours. The fifth is the preparation stage and the root tips are squashed with 45% acetic acid and assembled in Depex to become a permanent preparation.

Chromosomal measurements were performed with Software Image Analysis (Bs200Pro). The following parameters and formulae were used for chromosome classifications, detailed chromosomal measurements, intrachromosomal and interchromosomal asymmetry [11–13].

$$\text{CL (chromosome length)} = \text{LA (long arm)} + \text{SA (short arm)} \tag{1}$$

$$\text{AR (arm ratio)} = \frac{\text{LA}}{\text{SA}} \tag{2}$$

$$\text{CI (centromeric index)} = \frac{\text{SA}}{\text{LA} + \text{SA}} \times 100 \tag{3}$$

$$\text{THL (total haploid length)} = \text{CL1} + \text{CL2} + \cdots + \text{CL15} \tag{4}$$

$$\text{MHL (mean haploid length)} = \frac{\text{CL1} + \text{CL2} + \cdots + \text{CL15}}{n} \tag{5}$$

$$\text{RL (relative length)} = \frac{\text{LA} + \text{SA}}{\text{THL}} \times 100 \tag{6}$$

$$\text{MCA (mean centromeric asymmetry)} = \text{mean}\frac{\text{Total LA} - \text{Total SA}}{\text{Total LA} + \text{Total SA}} \times 100 \tag{7}$$

$$\text{CVCL (coefficient of variation of chromosome length)} = \frac{\text{SCL (standard deviation)}}{\text{MHL}} \times 100 \tag{8}$$

3. RESULTS AND DISCUSSION

Figure 1 and Figure 2 represent the metaphase chromosomes and ideogram in *Dianthus muglensis*. The karyotype formula is $2n = 2x = 30 = 20\text{m} + 10\text{sm}$ by metacentric and submetacentric chromosomes with no satellite and secondary constriction. THL and MHL are very low with 25.10 and 1.67 µm, respectively (Table 1).

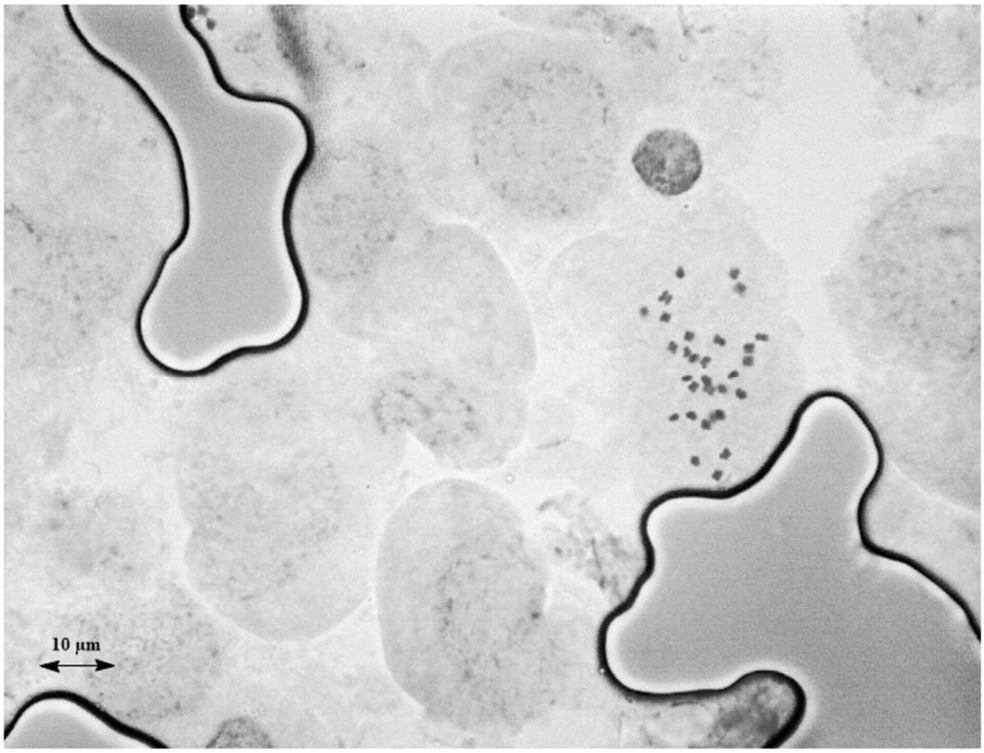

Figure 1. Somatic metaphase chromosomes of *Dianthus muglensis*

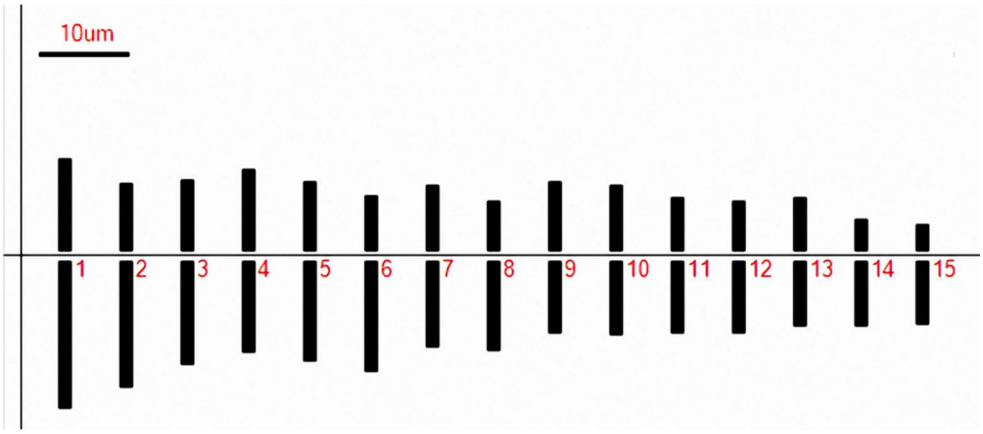

Figure 2. Monoploid ideogram of *Dianthus muglensis*

Table 1. The karyological parameters of *Dianthus muglensis*

Karyological parameters	
Chromosome type	Monocentric
Basic chromosome number (*x*)	15
Diploid chromosome number (2*n*)	30
Karyotype formula	20m + 10sm
Total haploid length (µm)	25.10
Mean haploid length (µm)	1.67
Mean centromeric asymmetry (M_{CA})	18.56
Variation coefficient of chromosome length (CV_{CL})	25.21

The chromosome number of *Dianthus muglensis* is recorded here for the first time. The chromosome lengths range between 1.02 and 2.65 µm. Chromosome arm ratio, relative length and centromeric index are ranging from 1.03 to 2.29, 6.22 to 10.56, and 30.39 to 49.37, respectively (Table 2).

Table 2. The detailed chromosome measurements of *Dianthus muglensis*

Chromosome pair	Chromosome Length (µm)	Long arm	Short arm	Arm ratio	Relative length (%)	Centromeric index (%)	Chromosome type
1	2.65	1.62	1.03	1.57	10.56	38.87	metacentric
2	2.17	1.40	0.77	1.82	8.65	35.48	submetacentric
3	1.94	1.14	0.80	1.42	7.73	41.24	metacentric
4	1.93	1.01	0.92	1.10	7.69	47.67	metacentric
5	1.90	1.11	0.79	1.40	7.57	41.58	metacentric
6	1.85	1.22	0.63	1.94	7.37	34.05	submetacentric
7	1.70	0.95	0.75	1.27	6.77	44.12	metacentric
8	1.58	1.00	0.58	1.72	6.29	36.71	submetacentric
9	1.58	0.80	0.78	1.03	6.29	49.37	metacentric
10	1.56	0.82	0.74	1.11	6.22	47.44	metacentric
11	1.42	0.81	0.61	1.33	5.66	42.96	metacentric
12	1.39	0.81	0.58	1.40	5.54	41.73	metacentric
13	1.33	0.72	0.61	1.18	5.30	45.86	metacentric
14	1.08	0.72	0.36	2.00	4.30	33.33	submetacentric
15	1.02	0.71	0.31	2.29	4.06	30.39	submetacentric

In many taxa in the genus *Dianthus*, the basic and diploid numbers are $x = 15$ and $2n = 30$, respectively [2,3,5,6]. In literature, there are different chromosome numbers such as $2n = 60$, 90, and 120 in the genus *Dianthus* [14]. In section *Fimbriati*, the diploid chromosome numbers are reported from seven taxa. Six of them are diploid ($2n = 2x = 30$) taxa, which are *Dianthus erythrocoleus* Boiss., *Dianthus orientalis* Donn subsp. *orientalis*, *Dianthus orientalis* subsp. *nassireddini* (Stapf) Rech.f., *Dianthus sessiliflorus* Boiss., *Dianthus stramineus* Boiss. & Heldr., and *Dianthus tabrisianus* Bien.ex Boiss. [2,8,9]. Only *Dianthus crinitus* showed both diploidy and polyploidy ($2n = 4x = 60$) [7,10]. The dominant chromosome number of the section *Fimbriati* is $2n = 30$. There is a similar situation in other Turkish *Dianthus* sections [3,5,6].

Dianthus muglensis has a karyotype formula containing metacentric and submetacentric chromosomes. However, subtelocentric chromosomes are also known in other taxa. In Section *Fimbriati*, karyotype formulae have been reported as 22m + 6sm + 2st, 18m + 8sm + 4st, 20m + 4sm + 6st, and 14m + 8sm + 8st [2]. In Section *Verruculosi*, the number of subtelocentric chromosomes is much higher and varies between 10 and 18 [3].

The values of intrachromosomal asymmetry (M_{CA}) and interchromosomal asymmetry (CV_{CL}) are 18.56 and 25.21, respectively. According to these values, *Dianthus muglensis* has a symmetrical karyotype. In literature, more asymmetrical karyotypes than the karyotype of *Dianthus muglensis* have been reported [2,3]. Since symmetrical karyotypes are generally seen in the early stages of karyotype evolution, *Dianthus muglensis* can be considered to be involved in the early stages of karyotype evolution.

4. CONCLUSION

In the present study, the karyological data of *Dianthus muglensis* are showed and the data are the first report. The listed data have made important contributions to the cytotaxonomy of genus *Dianthus*: (i) basic number of $x = 15$, (ii) diploid number of $2n = 30$, (iii) new karyotype formula of 20m + 10 sm (iv) ploidy level of $2x$, and (v) symmetrical karyotype.

AUTHOR'S CONTRIBUTIONS

The authors contributed equally.

CONFLICTS OF INTEREST

Authors have declared no conflict of interest.

RESEARCH AND PUBLICATION ETHICS

The author declares that this study complies with Research and Publication Ethics.

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