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Karyological study of some *Geranium* (*Geraniaceae*) species growing in Bulgaria

Abstract

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The chromosome numbers and the morphological characteristic of the karyotypes of eight *Geranium* species growing in Bulgaria have been studied. They belong to three subgenera and seven sections according to the classification of Yeo (1984).

Introduction

The genus *Geranium* L. comprises about 400 species (Willis 1973), thirty nine of which are native to Europe (Webb & Fergusson 1968). The most species diversity is restricted to the East Mediterranean region. Karyological data for about 25% of the species are known by the literature (Fedorov 1969; Goldblatt 1981, 1984, 1985, 1988, 1990, 1991, 1994, 1996), which concern mainly the chromosome numbers.

The genus is represented in Bulgaria by twenty three species (Petrova & Kozhuharov 1979), part of which karyologically has been previously studied by Andreev (1982), van Loon & van Setten (1982), van Loon (1984a, 1984b), Nikolov (1991), Petrova & Stanimirova (2001).

The chromosome numbers and the morphological characteristic of the karyotypes of eight species belonging to three subgenera and seven sections according to the taxonomical scheme of Yeo (1984) have been here studied.

Materials and methods

The species – living plants and seeds were collected from native populations from different parts of the country, than transplanted and grown in the greenhouse of the Institute of Botany, Bulgarian Academy of Sciences. Root tips were used in all cases. They were pretreated in 0,01% colchicin solution for 20 – 30 min and fixed in ethanol:acetic acid (3:1) at room temperature, hydrolyzed in 1N HCl at 60°C for 15 min and stained with haematoxylin after Gomory (modified after Melander & Wingstrand 1953). The roots were squashed in a drop of 45% acetic acid.

1. Subg. *Geranium*

1.1. Sect. *Geranium*



Figs 1 - 7. Karyotypes of : 1, *Geranium palustre*, $2n = 28$; 2, *Geranium asphodeloides*, $2n = 24$; 3 - 4, *Geranium bohemicum*, $2n = 28$, 56; 5, *Geranium purpureum*, $2n = 32$; 6 - 7, *Geranium pusillum*, $2n = 26$, 52.

1.1.1. *G. palustre* L. — $2n = 28$ (Fig. 1).

Specimens studied: Rila Mt, Borovets, humid grassy places near the lift station Sitnyakovo, 1400 m alt., 42°14'N, 23°38'E, Petrova & Stanimirova 50200 (SOM).

The chromosome number presented confirms the previous counts of Gauger (1937), Pólya (1950), Murin (1974), Turala-Szybowska (1976), van Loon (1984a) and others (see Goldblatt 1991, 1994). Chromosome number $2n = 56$ is also reported in the literature (Gauger l.c.). The karyotype studied consists of six pairs of metacentric, six pairs of submetacentric and two pairs of SAT submetacentric chromosomes. The chromosomes are almost equal in size without considerable differences between the largest and the shortest chromosome pairs.

1.2. Sect. *Dissecta* Yeo

1.2.1. *G. asphodeloides* Burm. fil. — $2n = 24$ (Fig. 2).

Specimens studied: Strandzha Mt, the biosphere reserve Lopushna (Uzunbodzhak), in the *Quercus frainetto* forest, 100 m alt., 42°04'N, 27°47'E, Petrova & Stanimirova 59200 (SOM).

The chromosome number received confirms the data of van Loon & Oudemans (1982), van Loon (1984a), Baltisberger (1991) in plants from Greece. Strid & Franzen (1981) reported the chromosome number $2n = 30$ and observed additional chromosome fragments in plants from the same country.

The karyotype studied by us consists of one pair of metacentric, ten pairs of submetacentric and one pair of SAT chromosomes of submetacentric type with small differences in the size between the chromosomes.

1.3. Sect. *Tuberosa* (Boiss.) Reiche

1.3.1. Subsect. *Mediterranea* Knuth

1.3.1.1. *Geranium bohemicum* L. — $2n = 28$ (Fig. 3).

Specimens studied: Eastern Sredna gora Mt, grassy places at the foot of the summit Chivira, 1300 m alt., 42°36'N, 24°30'E, Petrova & Stanimirova 60200 (SOM).

The chromosome number agrees with data reported by Dahlgren (1952) and van Loon (1984b). The karyotype consists of nine pairs of metacentric, three pairs of submetacentric and two pairs of SAT chromosomes of meta- and submetacentric type respectively. Some differences in the size of the chromosomes are observed. For this species like the other representatives of the genus, together with the diploid chromosome number (Fig. 3), the tetraploid $2n = 56$ (Fig. 4) is also observed.

2. Subg. *Robertium* (Picard) Rouy

2.1. Sect. *Robertia*

2.1.1. *G. purpureum* Vill. — $2n = 32$ (Fig. 5).

Specimens studied: Strouma valley, the locality Rupite, eastern slope of the hill Kozhuha, 200 m alt., 41°27'N, 23°17'E, Petrova & Stanimirova 2371 (SOM).

The chromosome number confirms the data in the literature — Löve & Kjellqvist (1974), Alves & Leitão (1976), Natarajan (1978), Löve & Löve (1982), van Loon (1984b), Dalgaard (1986) and others (see Fedorov 1969). Luque & Diaz Lifante (1991) reported $2n$

= 64 in plants from Spain. The karyotype consists of twelve pairs of metacentric; three pairs of submetacentric and one pair of SAT – metacentric chromosomes. Considerable differences in the size between the chromosomes are observed.

2.2. Sect. *Batrachioidea* W. D. J. Koch

2.2.1. *G. pusillum* L. — $2n = 26$ (Fig. 6).

Specimens studied: Central Stara planina Mts, rocky, grassy places near Karlovo, 500 m alt., 42°41'N, 24°49'E, Petrova & Stanimirova 25259 (SOM).

The chromosome number received is the same reported in the literature by Fritsch (1973), Murín (1974), Alves & Leitão (1976), Turala-Szybowska (1976), Fernández Casas, Pajarón & Rodríguez Pascual (1978) and others (see Fedorov 1969). Van Loon (1984b) reported the same chromosome number in plants originated also from Central Stara planina. The karyotype studied by us consists of eight pairs of metacentric, three pairs of submetacentric and two pairs of SAT – metacentric chromosomes, differing in size. The double homologous chromosome number - $2n = 52$ (Fig. 7) is also observed for this species.

2.2.2. *G. molle* L. — $2n = 26$ (Fig. 8).

Specimens studied: Strouma valley, the locality Rupite, northern slope of the hill Kozhuha, 200 m alt., 41°27'N, 23°16'E, Petrova & Stanimirova 2358 (SOM).

The chromosome number received agrees with data in the literature - Murín (1978), Natarajan (1978), Franzen & Gustavsson (1983), van Loon (1984b) and others (see Fedorov 1969; Goldblatt 1981). The karyotype consists of three pairs of metacentric, eight pairs of submetacentric and two pairs of SAT chromosomes, of meta- and submetacentric type respectively. Some differences in the size of the chromosomes are also observed.

2.3. Sect. *Lucida* Knuth

2.3.1. *G. lucidum* L. — $2n = 40$ (Fig. 9).

Specimens studied: Strouma valley, grassy, rocky places above the locality Kresnensko hanche, 600 m alt., 41°45'N, 23°11'E, Petrova & Stanimirova 2356 (SOM).

The chromosome number coincides with the reports of Alves & Leitão (1976), Strid & Franzen (1981), Galland (1988), Luque & Diaz Lifante (1991). Löve & Kjellqvist (1974), Uhríková & Májovský (1980) reported $2n = 20$. Aryavand (1983) published $n = 30$. Van Loon (1984b) reported different chromosome numbers: $2n = 40, 41, 42, 43, 44$. Galland (l.c.) determined $2n = 42$ in plants from Switzerland.

The karyotype studied consists of five pairs of metacentric, twelve pairs of submetacentric and three pairs of SAT chromosomes of submetacentric type. The double homologous chromosome number for this species is also observed - $2n = 80$ (Fig. 10).

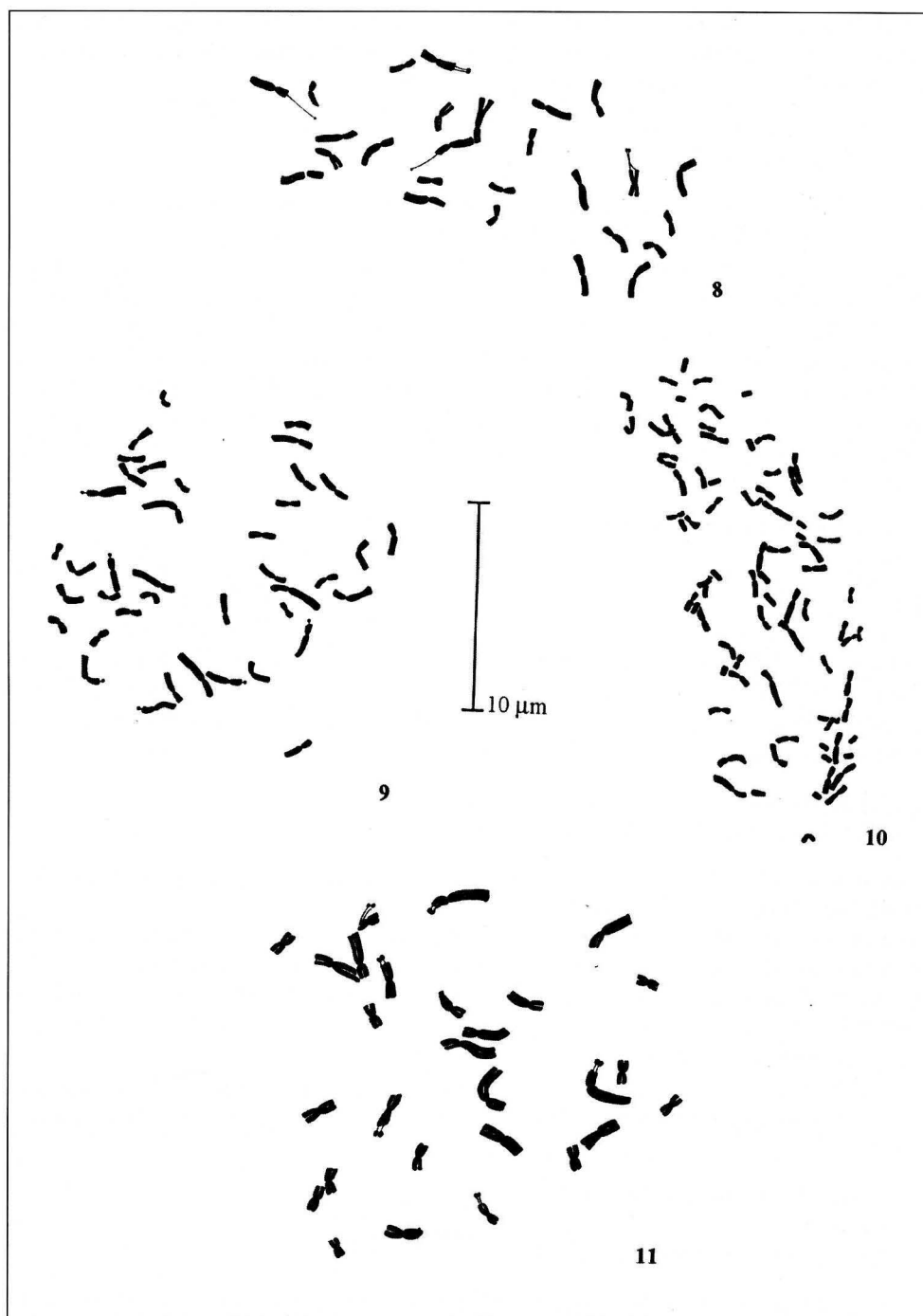
3. Subg. *Erodioideae* (Picard) Yeo

3.1. Sect. *Erodioideae*

3.1.1. *G. phaeum* L. — $2n = 28$ (Fig. 11).

Specimens studied: Western Stara planina Mts, grassy places at the foot of the summit Midzhour, 1500 m alt., 43°25'N, 22°43'E, Petrova & Stanimirova 3998-1 (SOM).

The chromosome number confirms the data in the literature reported by Skalińska



Figs 8 - 11. Karyotypes of: 8, *Geranium molle*, $2n = 26$; 9 - 10, *Geranium lucidum*, $2n = 40, 80$; 11, *Geranium phaeum*, $2n = 28$.

(1959), Uhríková (1970), van Loon (1984a), Krahulcová (1990). The karyotype of the population studied consists of seven pairs of metacentric, four pairs of submetacentric and three pairs of SAT chromosomes - two pairs being of metacentric and a pair of submetacentric type. Very clear differences in the size between the chromosomes are observed.

Conclusion

The chromosome numbers of the eight species of the genus *Geranium* growing in Bulgaria as well as the morphological characteristics of their karyotypes have been determined. These results and the previous studies of the other species (Petrova & Stanimirova in press) confirm the reports of many other authors about the different basic chromosome number in the genus: $x = 10$ ($2n = 4x = 40$) - *G. lucidum*, $x = 12$ ($2n = 2x = 24$) - *G. asphodeloides*, $x = 13$ ($2n = 2x = 26$) - *G. pusillum*, *G. molle*, $x = 14$ ($2n = 2x = 28$) - *G. palustre*, *G. bohemicum*, *G. phaeum*, $x = 16$ ($2n = 2x = 32$) - *G. purpureum*. The most common basic chromosome number is $x = 14$ (Albers 1990).

Seven of the species studied are diploid and only one is tetraploid. For three of the species studied a double chromosome number together with the homologous one are also observed - *G. pusillum* - $2n = 52$ (Fig. 7); *G. bohemicum* - $2n = 56$ (Fig. 4), *G. lucidum* - $2n = 80$ (Fig. 10). The phenomenon is noted as endomitosis (Geitler 1939) conducting to endopolyploidy (Löve & Löve 1975) and often occurs in the species of the genus.

The morphological characteristics of the karyotypes analysed show some degree of asymmetry due to the considerable differences in the size between the largest and the shortest chromosomes. In all karyotypes studied the SAT chromosomes of meta- and submetacentric types have been also observed.

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