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Karyology of Seven Fabaceae Taxa from Turkey

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Abstract

The paper gives an account of the results of karyological investigation of seven Fabaceae taxa from Turkey. Chromosome morphologies and chromosome numbers of taxa belonging to *Spartium* L., *Vicia L., Trifolium* Gerard & Lois.and *Coronilla* L. are reported. The karyotype of *Coronilla scorpioides* was presented for the first time. Chromosome numbers were established for *Spartium junceum* L. (2n = 52), *Vicia peregrina* L. (2n = 14), *Vicia anatolica* Turrill. (2n = 10), *Vicia hybrida* L. (2n = 12), *Vicia narbonensis* var. *narbonensis* (2n = 14), *Trifolium aureum* Poll. (2n = 20) and *Coronilla scorpioides* (L.) Koch. (2n = 12). The new data were compared with previous information karyologically. For each chromosome, the arm index was calculated and based on these data, idiograms were drawn. Chromosome characteristics investigated taxa are determined by using karyological tecniques.

Keywords: Chromosome number, cytotaxonomy, Fabaceae, karyotype.

INTRODUCTION

Fabaceae especially distributes in Eastern and South- East Anatolia in Turkey. These regions are gene center of most Fabaceae members [1]. 10 000 native species of family containing 350 genera are present in the world, nearly 61 genera and species more than 900 of them grown in Turkey [2]. There are very important species for human and animals. Moreover, most of species are used in medicine industry and as ornament plant. Therefore, they are economically important. Most of Fabaceae taxa are cultivated in various countries. They are sown in winter in California (U.S.A) to protect soil. They are used in animal nutrition because its straw contains 10- 20 % protein and its seeds are used in fodder of poultry [3].

It is reported that most of genera belong to Fabaceae have many taxonomic problems. Many of the species have highly variabilities both genetically and in response to environmental differences [2].

Spartium L. distributed in Mediterranean in our country is monotypic. Genus *Vicia* L. is represented six section with 59 species, 22 subspecies and 18 varieties. Five species and three subspecies of them are endemic for Turkey. Genus *Trifolium* Gerard & Lois. is represented in eight section with 94 species, 18 taxa of them endemic in Turkey. Genus *Coronilla* L. is seperated into eight species and four varieties. Only one species belongs to the genus is endemic for our country [2]. There are a large number of investigations concerning karyological studies in our country and abroad [4- 11].

We reported chromosome numbers of seven Fabaceae taxa from Turkey in the present work. Chromosome characteristics of one of these taxa is presented for the first time. The new data are compared with previous karyological information. The objectives of this paper were to make a cytotaxonomic classification and to determine chromosome characteristics of species unknown chromosome number and karyotypic features.

MATERIALS and METHODS

Plant materials were collected from natural habitats between 2005- 2007 in vicinity of Lake Karakuyu (Afyonkarahisar- Turkey). The materials included one taxon from *Spartium*, *Trifolium* and *Coronilla*, and four taxon from *Vicia.* Specimens were deposited at the Herbarium of Süleyman Demirel University of Isparta.

The seeds were scarified with sandpaper and germinated in Petri dishes lined with moist filter paper. Roots, 1 cm long, were pretreated with a saturated solution of paradiclorobenzene for 4 h at 20 ºC, fixed with Carnoy (ethanol: acetic acid, 3:1) for 24 h, and stored in 70 % alcohol at 4 ºC until required. The slides were prepared by hydrolysing the roots with 1 N HCl at 60ºC for 15- 18 min, staining with Feulgen for 1 h, and squashing in 45 % acetic acid. For karyotype analyses, 10 cells with equivalent degrees of chromosome contraction were used. For each chromosome pair, the short arm, long arm, and total chromosome sized, arm ratio, centromeric index, relative length were determined [12]. Chromosome types were classified according to the nomenclature of Levan et al. [13]. The quantitative values were obtained from chromosome character measurements. They are chromosome number, total length, long arm length, short arm length, arm ratio, centromeric index, relative length and chromosome type.

RESULTS

In this work, chromosome morphology and character measurements of some Fabaceae taxa were determined (Table 1). The metaphase chromosomes, karyograms and idiograms of these taxa were shown in Fig. 1-3. Additionally, chromosome numbers, karyotype formula and chromosomal morphologies of all taxa were comprehensively detailed.

Table 1. Karyomorphological parameters of studied taxa. AR, arm ratio (L/S); C, total length; CI, centromeric index (100S/C); L, long arm; RL, relative length; S, short arm; Sat, satellite; Sk, secondary constriction; m; median; Sm, submedian; St, subterminal.

Chromosome Pair No.	C	L	S	Sat	AR	CI	RL	Type
V. peregrina								
1	1.47	0.77	0.19	0.51	4.05	12.92	9.64	St^{sat}
2	1.14	0.97	0.17		5.70	14.91	7.48	St
3	1.09	0.47	0.15	0.47	3.13	13.76	7.15	St^{sat}
4	1.07	0.90	0.17		5.29	15.88	7.02	St
5	1.03	0.87	0.16		5.43	15.53	6.75	St
6	0.97	0.80	0.17		4.70	17.52	6.36	St
7	0.85	0.70	0.15		4.66	17.64	5.57	St
V. anatolica								
1	1.73	0.82	0.61	0.30	1.34	35.26	14.91	$m^{Sk\ Sat}$
2	1.23	0.92	0.31		2.96	25.20	10.60	Sm
3	1.07	0.47	0.26	0.34	1.80	24.29	9.22	Sm^{Sat}
4	0.96	0.73	0.23		3.17	23.95	8.27	St
5	0.81	0.58	0.23		2.52	28.39	6.98	Sm
V. hybrida								
1	1.30	0.98	0.32		3.06	24.61	9.92	St
2	1.18	0.53	0.31	0.35	1.70	26.27	9.00	Sm^{Sat}
3	1.07	0.56	0.23	0.28	2.43	21.49	8.16	Sm^{Sat}
4	1.06	0.80	0.26		3.07	24.52	8.09	St
5	1.01	0.76	0.25		3.04	24.75	7.70	St
6	0.93	0.70	0.23		3.04	24.73	7.09	St
V. narbonensis* var. *narbonensis								
1	1.09	0.74	0.35		2.11	32.11	8.28	Sm
2	1.04	0.72	0.32		2.25	30.76	7.90	Sm
3	0.99	0.70	0.29		2.41	29.29	7.52	Sm
4	0.97	0.67	0.30		2.23	30.92	7.37	Sm
5	0.90	0.64	0.26		2.46	28.88	6.83	Sm
6	0.82	0.58	0.24		2.41	29.26	6.23	Sm
7	0.77	0.40	0.15	0.22	2.66	19.48	5.85	Sm^{Sat}
C. scorpioides								
1	0.44	0.29	0.15		1.93	34.09	10.57	Sm
2	0.39	0.25	0.14		1.78	35.89	9.37	Sm
3	0.35	0.22	0.13		1.69	37.14	8.41	m
4	0.33	0.21	0.12		1.75	36.36	7.93	Sm
5	0.31	0.19	0.12		1.58	38.70	7.45	m
6	0.26	0.16	0.10		1.60	38.46	6.25	m

Spartium junceum L.

Chromosome number: 2n = 52 (X = 13)

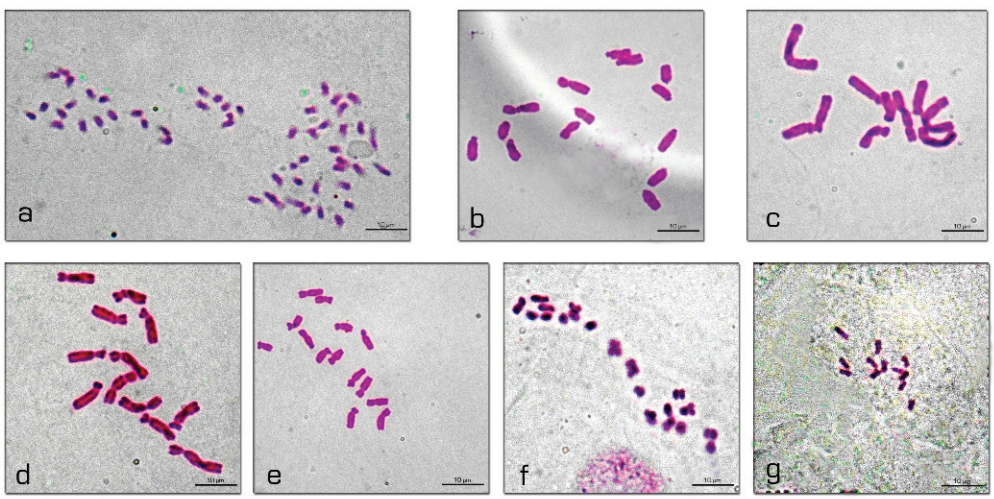
Karyotype Formula and Chromosomal Morphology: Since the taxon's chromosomes were too small to make a karyotype analysis, only was stated chromosome number of species (Fig. 1a).

Vicia peregrina L.

Chromosome number: 2n = 14 (X = 7)

Karyotype formula: K (X = 7) 1 St + 2 St+ 3 St^{Sat} + 4 St + 5 St + 6 St + 7 St

Chromosomal morphology: All chromosomes in the taxon have been determined as subterminal. I numbered chromosome has a satellite connected to short arm and satellite is approximately threefold as long as short arm. In addition, III numbered chromosome has also a satellite connected to long arm and almost equal with its long (Fig. 1b; 2a, 3a).



Vicia anatolica Turrill.

Fig. 1. Mitotic metaphase plates of the studied taxa. a) S. *junceum*. b) *V. peregrina*. c) *V. anatolica*. d) *V. hybrida*. e) *V. narbonensis* var. *narbonensis*. f) *T. aureum*. g) *C. scorpioides*. Bars = 10µm.

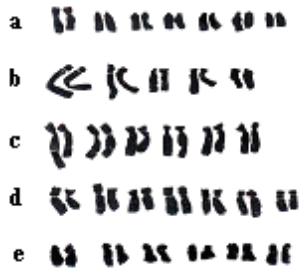


Fig. 2. Karyograms of the studied taxa. a) *V. peregrina*. b) *V. anatolica*. c) *V. hybrida*. d) *V. narbonensis* var. *narbonensis*. e) *C. scorpioides*

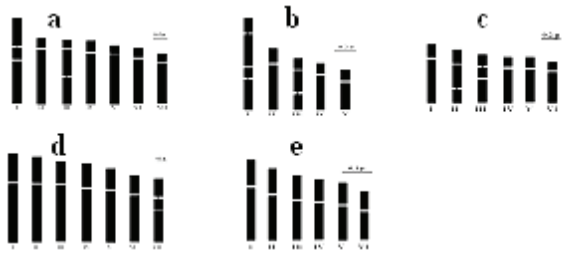


Fig. 3. Idiograms of the studied taxa. a) *V. peregrina*. b) *V. anatolica*. c) *V. hybrida*. d) V. *narbonensis* var. *narbonensis*. e) *C. scorpioides*. Bars of Fig. a- c = 0.2 µm, bars of Fig. d- e = 0.1 µm.

Vicia Anotolica Turrill.

Chromosome number: 2n = 10 (X = 5)

Karyotype formula: K (X = 5) 1m $^{Sk\ Sat}$+ 2 Sm + 3 Sm^{Sat} + 4 St + 5 Sm

Chromosomal morphology: I numbered chromosome is median and easily distinguished from other chromosome. Because it has a satellite in one arm and has secondary construction in another arm. IV numbered chromosomes is subterminal and the others are submedian centromered. III numbered chromosome also has a satellite connected to long arm (Fig. 1c; 2b, 3b).

Vicia hybrida L.

Chromosome number: 2n = 12 (X = 6)

Karyotype formula: K (X =6) 1 St + 2 Sm^{Sat} + 3 Sm^{Sat} + 4 St + 5 St + 6 St

Chromosomal morphology: II and III numbered chromosomes are submedian. The others are subterminal. There are satellite connecting with II. chromosome's long arm and III. chromosome's short arm (Fig. 1d; 2c, 3c).

Vicia *narbonensis* L. var. *narbonensis*

Chromosome number: 2n = 14 (X =7)

Karyotype formula: K (X = 7) 1 Sm + 2 Sm + 3 Sm + 4 Sm + 5 Sm + 6 Sm + 7 Sm ^{Sat}

Chromosomal morphology: It was determined that all of the chromosomes of the taxon were submedian centromered. VII numbered chromosome has a satellite connected short arm and longer than it (Fig. 1e; 2d, 3d).

Trifolium aureum Poll.

Chromosome number: 2n = 20 (X =10)

Karyotype Formula and Chromosomal Morphology: The taxon's karyotype were not made because its chromosomes are very small. Therefore, chromosome number of the species was only determined (Fig. 1f).

Coronilla scorpioides (L.) Koch.

Chromosome number: 2n = 12 (X = 6)

Karyotype formula: K (X = 6) 1 Sm + 2 Sm + 3 m + 4 Sm + 5 m + 6 m

Chromosomal morphology: I, II and IV numbered chromosomes are submedian and the others are median centromered. It was not observed satellite in taxon. According to other taxa studied karyological analysis, chromosomes of *Coronilla scorpioides* are very small (Fig. 1g; 2e, 3e).

DISCUSSION

In the present study, seven taxa belong to genus *Spartium*, *Vicia, Trifolium* and *Coronilla* of Fabaceae were investigated cytotaxonomically. The metaphase chromosomes, karyograms and idiograms of all taxa studied were explained comprehensively (Fig 1- 3).

Consequently, the chromosome number of *Spartium junceum* was found 2n = 52. The taxon's chromosomes were too small to make a karyotype analysis. In literature researches, any information deal with karyotype morphology of the species could not be found. However, chromosome number of the species was found similar to results of Tutin et al. [14]. They reported that basic chromosome number of the taxon were x = 13. We can say with confidence that the species is a tetraploid (2n = 4x = 52).

V. peregrina was found as 2n = 14. Chromosome numbers of this species were consistent with the result of Mettin & Hanelt [15], Löve [5], Yamamato [16], Raina & Rees [17], Şahin & Babaç [18] and Tabur [20]. According to Löve [5] and Raina & Rees [17], I numbered chromosome were submedian, VII numbered chromosome were terminal and the other chromosomes were subterminal. They was not mentioned another satellite. Yamamoto [16] determined that I numbered chromosome was submedian, the other chromosomes were subterminal and IV numbered chromosome had satellite connected to long arm. Our findings observed that I numbered chromosome had a satellite connected to short arm and satellite was approximately threefold as long as short arm. In addition, total chromosome length was 0.85- 1.47 µ, its relative length was 5.57- 9.64 µ and its arm rate was 3.13- 5.70 µ (Table 1).

V. anatolica was found as 2n = 10. It was determined that I numbered chromosome had a satellite in one arm and had

secondary construction in another arm. Besides, it was mentioned that another satellite were connected to III numbered chromosome's long arm. These finding were quite similar to results of Tabur et al. [19]. Şahin & Babaç [21] suggested that all of the chromosomes of the taxon were subterminal centromered and not observed another satellite. The chromosome number of the species is same as the results of Maxted et al. [22]. In this study, total chromosome length of *V. anatolica* was 0.81- 1.73 µ, its relative length was 6.98- 14.91 µ and its arm rate was 1.34- 3.17 µ (Table 1).

V. hybrida was found as 2n = 12. We determined that II and III numbered chromosomes were submedian, the others were subterminal and had one each satellite connecting II numbered chromosome's long arm and III numbered chromosome's short arm. Chromosome number of *V. hybrida* were found consistent with Yamamoto [16], Löve [6], Raina & Rees [17], Şahin & Babaç [18] and Tabur et al.[19]. Yamamoto [16] mentioned only one satellite connecting II. chromosome's long arm. Şahin & Babaç [18] reported that II numbered chromosome was median and with satellite, the others were subterminal. Tabur et al. [19] informed that II numbered chromosome were median and with satellite, I numbered chromosome was subterminal, the others were submedian centromered. In this study, total chromosome length of *V. hybrida* was 0.93- 1.30 µ, its relative length was 7.09- 9.92 µ and its arm rate was 1.70- 3.07 µ (Table 1).

V. narbonensis var. *narbonensis* was found as 2n = 14. We determined that all of the chromosomes of this taxon were submedian and had a satellite connecting VII numbered chromosome's short arm and longer than it. These data are closely similar to results of Yamamoto [16] and Tabur et al [23]. However, Tabur et al [23] reported that the chromosome with satellite were subterminal. As for Yamamoto [16], he defined that the chromosome with satellite were VI numbered chromosome. Maxted et al [22] reported that the taxon had 3 pairs of submedian, 3 pairs of subterminal and 1 pair of subterminal carrying a large satellite. Löve [5] and Raina & Rees [17] also suggested that chromosome number of this taxon was 2n = 14. In our study, total chromosome length of this taxon was 0.77- 1.09 µ. Its relative length was 5.85- 8.28 µ and its arm rate was 2.11- 2.66 µ (Table 1).

Trifolium aureum was found as 2n = 20 but its karyotype analysis couldn't be made. Because the taxon's chromosomes were small for karyological studies. The chromosome number of this species were found similar to the results of Tutin et al [14]. However, Vižintin et al [24] and Vižintin and Bohanec [25] reported that *Trifolium aureum* was 2n = 16. As pointed out by Greilhuber [26], this variability should be predominantly caused by orthodox events, such as chromosomal rearrangements-duplications, deletions, spontaneous aneuploidy, polyploidi or other less frequent events. Procházka [27] also suggested that chromosome number of *T. aureum* were 2n = 40. Among the events mentioned above, polyploidy is the most event since it is occurs in 70% of all the angiosperms [28] and is also very pronounced in the genus *Trifolium* [29].

Coronilla scorpioides was found as 2n = 12. It was observed that I, II and IV numbered chromosome were submedian and the others median. Satellite was not observed in this species. The chromosome number of *C. scorpioides* were consistent with the results of Colombo et al [30]. The karyotype of *C. scorpioides* is presented for the first time in this study. Total chromosome length of this taxa was 0.26- 0.44 µ, its relative length was 6.25- 10.57 µ and its arm rate was 1.58- 1.93 µ (Table 1).

Karyotype and chromosome characteristics of some taxa belongs to Fabaceae were comparatively examined in this study. It is thought that these definations will be useful for floristic, monographic and revision researches, which will be held in the future. The karyotype results of taxa were compared with literature data. Chromosome properties of some taxa were reported for the first time in this study.

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REFERENCES

[1] Vavilov NI. 1951. The origin, variation, immunity and breeding of cultivated plants, Chronica Botanica Co., Waltham.

[2] Davis PH. 1970. Flora of Turkey and the East Aegean Islands. Edinburgh: Edinburgh University Press. 3: 274-324.

[3] Duke JA. 1981. Handbook of Legume of world economic importance. Plenum Press. Newyork and London. 271-286.

[4] Kuta E. 1980. Karyological studies on genus *Vicia* L. I. Acta Biologica Cracoviensia, Series Botanica. 22: 81- 99.

[5] Löve A. 1972. IOPB Chromosome numbers Reports 36. Taxon. 21: 333- 346.

[6] Löve A. 1976 a. IOPB Chromosome numbers Reports 53. Taxon. 25: 483- 500.

[7] Löve A. 1976 b. IOPB Chromosome numbers Reports 54. Taxon. 25: 631- 649.

[8] Stace CA.1980. Plant Taxonomy and Biosystematics. London: Edward Arnold 118- 121.

[9] Tabur S, Civelek Ş, Bağcı E. 2000. Cytotaxonomic studies on some *Vicia* L. species growing in Eastern Mediterranean and Southern Aegean Regions I. Acta Botanica Gallica. 148 (2): 159- 174.

[10] Yamamoto K, Fujıwara T, Blumenreıch, ID. 1984. Karyotypes and morphological characteristics of some species in the *Lathyrus* L. Japanese Journal of Breeding. 34: 273-284.

[11] Yamamoto K. 1986. Interspecific hybridization among *Vicia narbonensis* and its related species. Biologisches Zentrablatt. 105: 181- 197.

[12] Elçi Ş. 1982. Sitogenetikte gözlemler ve araştırma yöntemleri. Elazığ: Fırat University Pres.

[13] Levan A, Fredga K, Standberg AA. 1964. Nomenclature for centromeric position on chromosomes. Hereditas. 52: 201- 220.

[14] Tutin TG, Halliday G, Beadle M. 1980. Flora Europaea 5. Cambridge: Cambridge University Pres.

[15] Mettin D, Hanelt P. 1968. Bemerkungen zur karyologie und sistematik einiger sippen der gattung Vicia L. Feddes Repertorium. 77 (1): 11- 30.

[16] Yamamoto K. 1973. Karyotaxonomical studies on *Vicia* L. I. On the karyotype and character of some annual species of Vicia. The Japanece Journal of Genetics. 48 (5): 315-327.

[17] Raina SN, Rees H. 1983. DNA variation between and within chromosome complement of *Vicia* L. species. Heredity. 51 (1): 335– 346.

[18] Şahin A, Babaç MT. 1995. Doğu ve Güneydoğu Anadolu'da yetişen bazı *Vicia* L. türleri üzerinde sitotaksonomik araştırmalar II. Turkish Journal of Botany. 19 (83): 293- 297.

[19] Tabur S, Civelek Ş, Bağcı E. 2002. Cytotaxonomic studies on some *Vicia* L. species growing in Eastern Mediterranean and Southern Aegean Regions II. Acta Botanica Hungarica.44 (1- 2): 185- 204.

[20] Tabur S. 2005. Cytotaxonomic studies on some Fabaceae taxa naturally grown in Turkey. Bulletin of Pure and Applied Sciences. 24B (2): 81- 90.

[21] Şahin A, Babaç MT. 1990. Doğu ve Güneydoğu Anadolu'da yetişen bazı *Vicia* L. türleri üzerinde sitotaksonomik araştırmalar I. Doğa Türk Botanik Dergisi. 14 (2): 124- 138.

[22] Maxted N, Callimassia MA, Bennett D. 1991. Cytotaxonomic studies of Eastern Mediterranean *Vicia* species (Leguminosae). Plant Systematics and Evolution. 177: 221- 234.

[23] Tabur S, Civelek Ş. 1999. Güneybatı Anadolu Bölgesi'nde yetişen iki *Vicia narbonensis* L. taksonu üzerinde sitataksonomik bir araştırma. I. International Symposium on Protection of Natural Environment and Ehrami Karaçam, 23- 25 Semptember 1999, Kütahya / Türkiye.

[24] Vižintin L, Javornik B, Bohanec B. 2006. Genetic characterization of selected *Trifolium* species as revealed by nuclear DNA content and ITS rDNA region analysis. Plant Science. 170(4): 859- 866.

[25] Vižintin L, Bohanec B. 2008. Measurment of nuclear DNA content of the genus *Trifolium* L. as a measure of genebank accession identy. Genet Resour Crop Evol. DOI 10.1007/s10722-008-9331-0

[26] Greilhuber J. 1998. Intraspecific variation in genome size: a critical reassessment. Annals of Botany. 82 (Suppl. A): 27- 35.

[27] Procházka F. 1980. Naße Orchideje. Pardubice, Czech Republic.

[28] Ohri D. 1998. Genome size variation and plant systematics. Annals of Botany. 82 (Suppl. A): 75- 83.

[29] Zohary M, Heller D. 1984. The genus *Trifolium*. The Israel Academy of Science and Humanities. Jerusalem, 1- 51.

[30] Colombo P, Marcenó C, Princiotta R. 1983. Nùmeros cromosomáticos de Plantas Occidentales, 200- 210. Anales del Jardín, Botánico de Madrid 39 (2): 519- 524. Italia.