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Karyological Studies on Nine Astragalus L. Taxa in Turkey

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ABSTRACT
The somatic chromosome number and morphometric properties of nine *Astragalus* taxa native to Turkey were studied in detail. Somatic chromosome numbers have been determined as follows: *A. campylorhynchus* Fisch. & C.A.Mey., *A. suberosus* Banks & Sol., *A. densifolius* Lam. subsp. *densifolius, A. cretaceus* Boiss., *A. leporinus* Boiss. var. *hirsutus* (Post) Chamberlain, *A. anthylloides* Lam., *A. odoratus* Lam. 2n=16, *A. lamarckii* Boiss. 2n=32, *A. camptoceras* Bunge, diploid chromosome number 2n = 2x = 16 and 2n = 4x = 32 tetraploid were seen in the cells. Chromosomes of *Astragalus* taxa, whose karyotype analyses were made, generally had metacentric and sub-metacentric chromosomes. In *A. densifolius* Lam. subsp. *densifolius* taxon, one pair satellite chromosomes (sat-chromosome) were observed. Among the species *A. leporinus* var. *hirsutus* and *A. lamarckii* were identified for the first time.

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Türkiye'deki Dokuz Astragalus L. Taksonu Üzerine Karyalojik Çalışmalar

ÖZET
Türkiye'de doğal olarak yayılış gösteren dokuz *Astragallus* taksonunun somatik kromozom sayısı ve morfometrik özellikleri detaylı bir şekilde incelenmiştir. İncelenen hücrelerde somatik kromozom sayıları; *A. campylorhynchus* Fisch. & C.A.Mey., *A. suberosus* Banks & Sol., *A. densifolius* Lam. subsp. *densifolius, A. cretaceus* Boiss., *A. leporinus* Boiss. var. *hirsutus* (Post) Chamberlain, *A. anthylloides* Lam., *A. odoratus* Lam. 2n=16, *A. lamarckii* Boiss. 2n=32, *A. camptoceras* Bunge, diploid kromozom sayısı 2n = 2x = 16 tetraploid kromozom sayısı 2n = 4x = 32 olarak belirlenmiştir. Karyotip analizi yapılan *Astragallus* taksonlarının kromozomları genellikle metasentrik ve sub-metasentriktir. *A. densifolius* Lam. subsp. *densifolius* taksonunun kromozomlarında bir çift satellit görülümüştür. Bu türler arasında, *A. leporinus* var. *hirsutus* ve *A. lamarckii*, ninn karyotip analizi ilk kez belirlenmiştir.

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INTRODUCTION
Fabaceae is the third largest plant family on earth after the Orchidaceae and Asteraceae, with an estimated 19.000 species (Lewis et al., 2005; Toksoy et al., 2015). Fabaceae is the second largest flowering plant family with 1013 species belonging to 71 genera in Turkey (Erik and Tarıkahya, 2004; Toksoy et al., 2015). İlçim and Behçet (2016) stated that *Astragalus* is the largest genus of vascular plants with more than 250 sections and 2500-3000 taxa. It is divided into 64 sections and represented by 475 taxa including 202 endemic species in the Flora of Turkey (İlçim and Behçet, 2016). The genus is most widespread in southwest Asia (Akpulat and Çelik, 2007). Ghahremaninejad and Behçet (2003) observed the genus in the Irano-Turanian phytogeographic region of Turkey, which is one of the centers of diversity of the genus (Martin et al., 2008). *Astragalus* species are known of herbaceous, woody, thorny and pillow-shaped (Ekim, 1990). *Astragalus* species have been reported to possess compounds such as anti-cancer and immune system potentiating effect characteristics (Yeşilada et al., 2004). According to Badr and Sharawy (2007) many species of *Astragalus* exhibit valuable economic values.

Astragalus multiceps Benth, *Astragalus tribuloides* Del. and *Astragalus hamosus* L., are medically useful. *Astragalus cicer* L., is a promising legume species for forage production (Townsend, 1981). *Astragalus* genus has been stated to exhibit basic chromosome numbers of x = 7, 8, 11and 15 from diploid, tetraploid, hexaploid and octaploid (Sheidai et al., 2009). *Astragalus* is the largest and most problematic genus in the World (İlçim and Behçet, 2016). Since the chromosome numbers and structures of the plants are not affected by environmental factors, these karyological studies have great importance in confirming systematic data.

Within this study, somatic chromosome numbers of nine species have been explored for the genus *Astragalus*; *A. camptoceras*, *A. campylorhynchus*, *A. suberosus*, *A. densifolius* subsp. *densifolius*, *A. cretaceus*, *A. leporinus* var. *hirsutus*, *A. lamarckii*, *A. anthylloides* and *A. odoratus* and karyotype analyses have been made. The study aims to enable the classification of the genus through presenting the morphometric parameters, somatic chromosome numbers and karyotype analysis of *Astragalus* taxa common in Turkey as well as to make contribution to the other multidisciplinary studies conducted on these species.

MATERIAL and METHOD

The seed samples used in the study were collected from Elazığ province during 2002 and 2007. Table 1 demonstrates the locality information of the species. Karyological studies were performed on meristematic cells at the root tips of seeds which were germinated in petri dishes at 24 °C. Root tips were soaked in colchicine solution (0.05 %) for 2 hours at room temperature. The soaked root tips were fixed in the refrigerator in Farmer solution (1: 3) at 4 °C for 24 hours. Root tips were hydrolyzed for 8 min in 1 N HCl at 60 °C and stained in dark for 1 h in Feulgen stain (Elçi and Sancak, 2013; Gedik et al., 2016). During karyological analyses, the Olympus BX51 microscope and the Olympus Camedia C-4000 and a digital camera were used to take 5 different images showing the best distribution. Arm lengths, arm ratios, total chromosome size, relative height, centromere index, centromere status and karyotype formulas were determined by measuring the chromosomes in these images. Chromosomal asymmetry indices (A1, A2) were calculated depending on Romero (1986) while chromosomes were named according to Levan et al. (1964). Karyotype asymmetry was determined through various techniques; TF% by Huziwara, (1962), As K% index Arano, (1963), Syi and Rec indices Greilhuber and Speta (1976), Index A Watanabe et al., (1999).

Table 1. Localities and collector numbers of *Astragalus* taxa investigated

Taxa	2n	Localities	Collector No
A. camptoceras	16	Fırat University, Elazığ Province, 1060 m, 2002	*Kurşat (FUH) 3030*
A. camptoceras	32		
A.campylorhynchus	16	Baskil Province, 1410-1480 m area surrounding Bolucuk district, 2002	*Kurşat (FUH) 4164*
A. suberosus	16	Fırat University, Elazığ Province, 1060 m, 2002	*Kurşat (FUH) 3031*
A. densifolius* subsp. *densifolius	16	Baskil Province, 1600-1800 m. area surrounding Subaşı district, 2007	*Kurşat (FUH) 1394*
A. cretaceus	16	Hasan Mountain, Elazığ Province, 1800 m. 2007	*Kurşat (FUH) 3234*
A. leporinus* var. *hirsutus	16	Elazığ, Baskil, Bekçi mezrası, Yamaçlar, 1500-1750 m. 2007	*Kurşat (FUH) 2741*
A. lamarckii	32	Baskil Province, 1580-1700 m area surrounding Hacımustafa district, 2007	*Kurşat (FUH) 2178*
A. anthylloides	16	Hasan Mountain, Elazığ Province, 1850 m. 2007	*Kurşat (FUH) 3345*
A. odoratus	16	Hasan Mountain, Elazığ Province, 1900-2000 m. 2007	*Kurşat (FUH) 3634*

RESULTS and DISCUSSION

The examined karyological characteristics of nine species of *Astragalus* and the characteristics of each species is presented as follows.

Astragalus camptoceras Bunge

A. camptoceras belongs to section *Oxyglottis.* Annual species grow on the steppe at an altitude of between 650 and 800 metres (Chamberlain and Matthews, 1970). Haploid chromosome n=8 was recorded in previous studies conducted on this species (Maassoumi, 1987). In this study, diploid chromosome number has been determined as 2n=16 and 2n=32. *A. camptoceras* (2n=2x=16) has 4 metacentric and 12 sub-metacentric chromosomes. The chromosome length varies between 1.44 and 2.12 µm, the ratio of the longest chromosome to shortest chromosome is 1.4:1. Chromosome arm ratios range from 1.55 to 2.50 µm. The centromeric index varies between 28.49 µm and

38.07 µm and relative lengths differ from 10.13 µm to 14.88 µm. The species (2n=4x=32) have 8 metacentric and 24 sub-metacentric chromosomes. The chromosome length ranges from 1.53 to 2.84 µm and the ratio of the longest to shortest chromosome is 1.8:1. Chromosome arm ratios range from 1.40 to 2.11 µm. The centromeric index varies between 32.09 µm and 41.66 µm and relative lengths range from 4.27 µm to 7.96 µm (Tables 2-3, Figures 1-2).

Astragalus campylorhynchus Fisch. & C.A. Mey.

A. campylorhynchus belongs to section *Harpibolus*. This is an annual species that grows in cultivated fields between altitudes of 800 and 1300 m (Chamberlain and Matthews, 1970). In previous studies, the haploid chromosome number was determined as n=8 (Maassoumi, 1986; 1987). However, the current chromosome number has been determined as 2n=16 in this study. The species has 6 metacentric and 10 sub-metacentric chromosomes. Metaphase chromosome length varies between 1.80 and 3.34 µm and the ratio of the longest to shortest chromosome is 1.8:1. Chromosome arm ratios range from 1.03 to 2.59 µm. Centromeric index ranges from 27.78 µm to 49.10 µm. The relative lengths vary from 9.19 µm to 17.01 µm (Tables 2-3, Figures 1-2).

Astragalus suberosus Banks & Sol.

A. suberosus belongs to section *Platyglottis.* This is prostrate annual or prennial species that grows waste ground, fields between altitudes of 700 and 1500 m (Chamberlain and Matthews, 1970). There is no data regarding the chromosome number and morphology of this species in the relevant literature. The chromosome number and morphology have been determined by Kurşat et al. (2014). The chromosome number of the *A. suberosus* was found to be 2n=16. The species has 16 sub-metacentric chromosomes. The chromosome lengths range from 2.25 to 3.58 µm and the ratio of the longest to shortest chromosome is 1.5:1. Chromosome arm ratios have been determined as 1.99-2.64 µm. Centromeric index ranges between 27.45 µm and 33.42 µm and relative lengths vary from 9.47 µm to 15.07 µm (Tables 2-3, Figures 1-2).

Astragalus densifolius Lam. subsp. densifolius

A. densifolius Lam. subsp. *densifolius* belongs to section *Dasyphyllium.* This is an Iran Turan Element that grows in mixed woodland, steppe and limestone slopes at the altitudes of 1200 and 2400 m (Chamberlain and Matthews, 1970). The related studies have revealed that the chromosome number is 2n=16 (Aytaç, 1997). In this study, the chromosome number of the species was identified to be 2n=16 (Kurşat et al., 2014). *A. densifolius* subsp. *densifolius* has 14 metacentric and 2 sub-metacentric chromosomes. Chromosome lengths range from 3.93 to 5.38 µm and the ratio of the longest to shortest chromosome is 1.3:1. Chromosome arm ratios have been measured as 1.00-1.95 µm. Centromeric index ranges from 33.89 to 49.89 µm, and relative lengths vary between 10.41 µm and 14.26 µm (Tables 2-3, Figures 1-2).

Astragalus cretaceus Boiss.

A. cretaceus belongs to section *Dasyphyllium.* This is perennial species and is Iran Turan Element grown especially at calcareous slopes and screes at the altitudes of 600 to 1520 m (Chamberlain and Matthews, 1970). The chromosome number used to be noted as 2n=16 (Cartier, 1979) in previous studies. This current study has determined the chromosome number of the species as 2n=16. *A. cretaceus* has 12 metacentric and 4 sub-metacentric chromosomes. Chromosome lengths range from 3.08 to 4.18 µm and the ratio of the longest to shortest chromosome is 1.3:1. Chromosome arm ratios have been measured as 1.90-2.36 µm. Centromeric index ranges from 32.89 to 44.48 µm, and relative lengths vary from 10.76 µm to 14.61 µm (Tables 2-3, Figures 1-2).

Astragalus leporinus Boiss. *var. hirsutus* (Post) D.F. Chamb.,

A. leporinus Boiss. var. *hirsutus* belongs to section *Myobroma*. This is an endemic perennial species and Iran Turan Element that grows in Quercus and Pinus woods, shaly hill-sides and fields etc., at the altitudes of 600 and 1500 m (Chamberlain and Matthews, 1970). No data related to the karyology of this species have been found in the related literature. However, the chromosome number and morphology have been determined in the present study. Chromosome number of the species has been found to be 2n=16. The species has 4 metacentric and 12 sub-metacentric chromosomes. Chromosome lengths range from 2.10 to 3.43 µm and the ratio of the longest to shortest chromosome is 1.6:1. Chromosome arm ratios have been determined as 1.37-2.54 µm. Centromeric index ranges from 28.20 to 42.02 µm, and relative lengths vary from 9.72 µm to 15.86 µm (Tables 2-3, Figures 1-2).

Astragalus lamarckii Boiss.

A. lamarckii belongs to section *Rhacophorus*. This is an endemic species and Iran Turan Element that grows in upland steppe and screes at altitudes of 920-1820 m (Chamberlain and Matthews, 1970). No data about the karyology of this species have been found in literature review and the chromosome number and morphology have been determined in this study.

Thus, the chromosome number of the species has been found to be 2n=32. *A. lamarckii* has 16 metacentric and 16 sub-metacentric chromosomes.

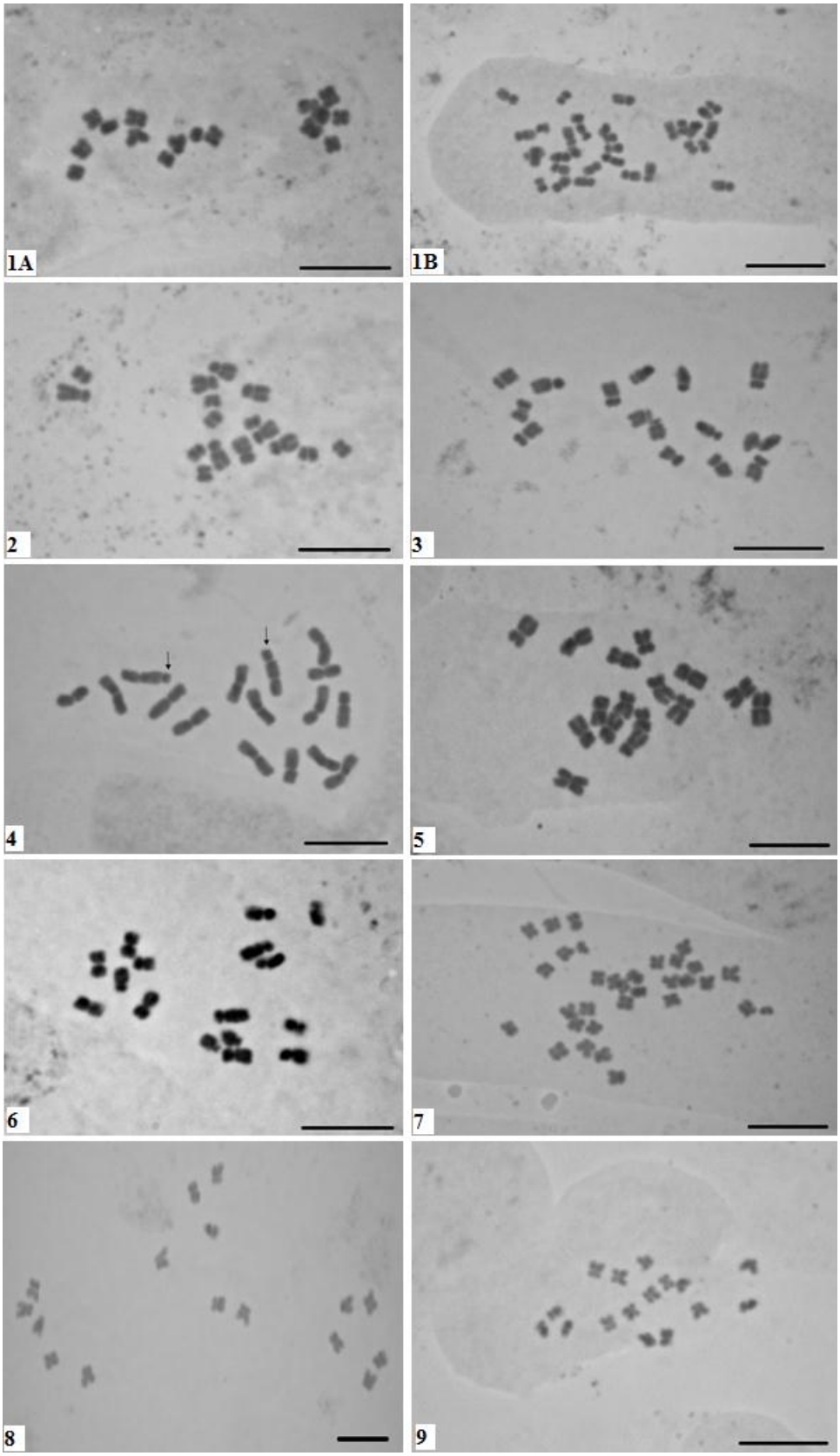

Figure 1. Somatic metaphases in *Astragalus* taxa. 1A- *A. camptoceras*, 1B- *A. camptoceras*, 2- *A.campylorhynchus*, 3- *A. suberosus*, 4- *A. densifolius* subsp. *densifolius*, 5- *A. cretaceus*, 6- *A. leporinus* var. *hirsutus*, 7- *A. lamarckii*, 8- *A. anthylloides*, 9- *A. odoratus* (Scale bar 10 µm).

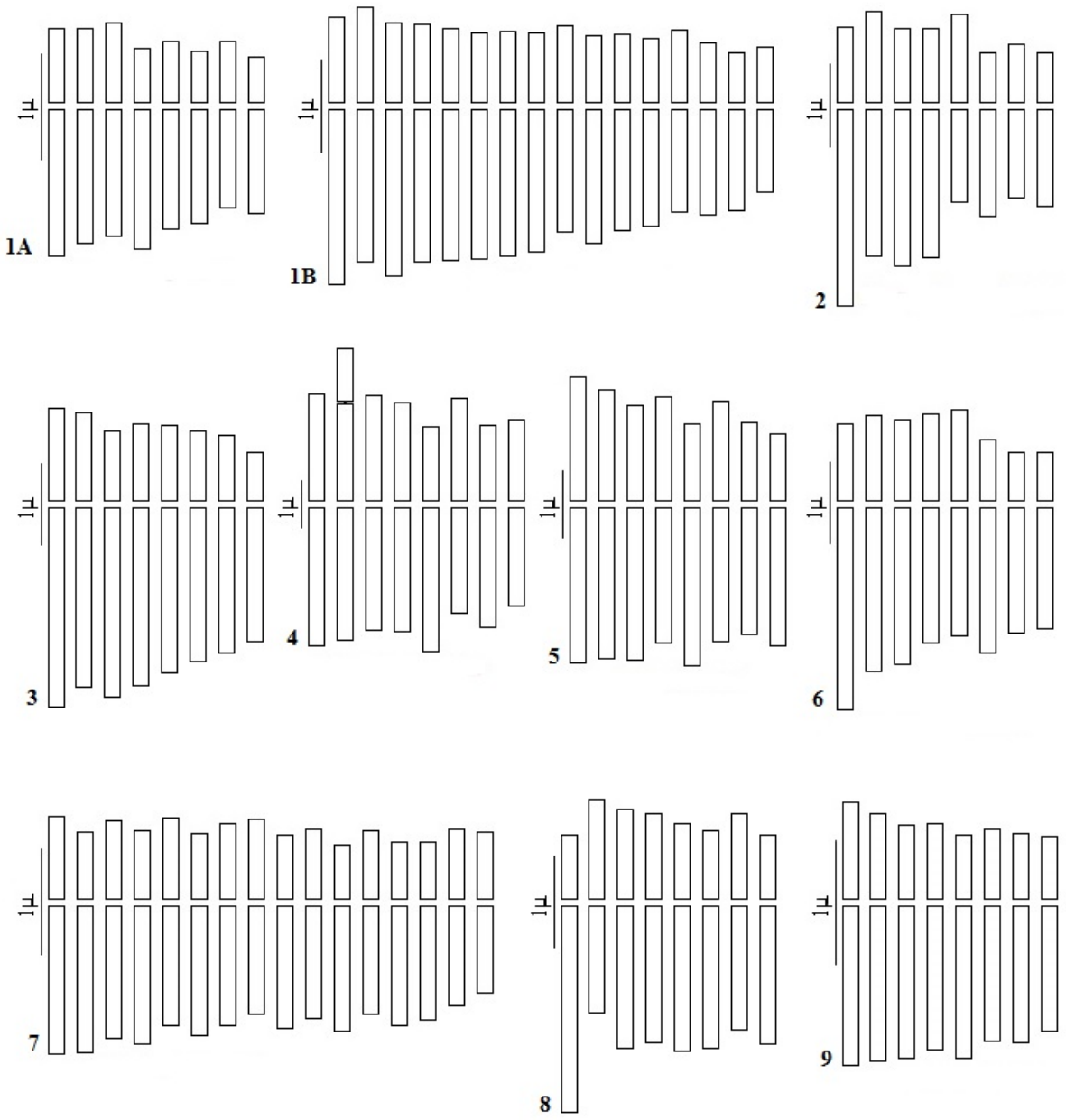

Figure 2. Haploid idiograms. 1A- *A. camptoceras* (2n=16), 1B- *A. camptoceras* (2n=32), 2- *A. campylorhynchus* (2n=16), 3- *A. suberosus* (2n=16), 4- *A. densifolius* subsp. *densifolius* (2n=16), 5- *A. cretaceus* (2n=16), 6- *A. leporinus* var. *hirsutus* (2n=16), 7- *A. lamarckii* (2n=32), 8- *A. anthylloides* (2n=16), 9- *A. odoratus* (2n=16).

Chromosome lengths range from 1.47 to 2.21 µm and the ratio of the longest to shortest chromosome is 1.5:1. Chromosome arm ratios have been measured as 1.29-2.24 µm. Centromeric index ranges from 30.86 to 43.63 µm, and relative lengths vary from 5.07 µm to 7.61 µm (Tables 2-3, Figures 1-2).

Astragalus anthylloides Lam.

A. anthylloides belongs to section *Halicacabus.* This is an Iran Turan Element that grows in steppe and scrubs at the altitudes of 750 to 1900 m (Chamberlain and Matthews, 1970). The chromosome number and morphology have been determined for the first time by Kurşat et al., (2014). The chromosome number of the species has been found as 2n=16. *A. anthylloides* has 8 metacentric and 8 sub-metacentric chromosomes. Chromosome lengths range from 2.21 to 2.96 µm and the ratio of the longest to shortest chromosome is 1.3:1. Chromosome arm ratios have been identified as 1.43-3.10 µm. Centromeric index ranges from 24.33 to 41.13 µm, and relative lengths vary from 11.12 µm to 14.88 µm (Tables 2-3, Figures 1-2).

Table 2 Somatic chromosome number (2n), ploidy level, karyotype formula, ranges of chromosome length, total karyotype length (TKL) for the studied *Astragalus* taxa.

Table 2. Somatic chromosome number (2n), ploidy level, karyotype formula, ranges of chromosome length, total karyotype length (TKL) for the studied *Astragalus* taxa

Taxa	2n	Ploidy level	Karyotype formula	Chromosome length range (µm)	TKL (µm)
A. camptoceras	16	2x	2m+6sm	1.44-2.12	14.27
A. camptoceras	32	4x	4m+12sm	1.53-2.84	35.77
A. campylorhynchus	16	2x	3m+5sm	1.80-3.34	19.64
A. suberosus	16	2x	8sm	2.25-3.58	23.79
A. densifolius subsp. *densifolius*	16	2x	1M+6m+1sm	3.93-5.38	37.75
A. cretaceus	16	2x	6m+2sm	3.08-4.18	28.66
A. leporinus var. *hirsutus*	16	2x	2m+6sm	2.10-3.43	21.64
A. lamarckii	32	2x	8m+8sm	1.47-2.21	29. 13
A. anthylloides	16	2x	4m+4sm	2.21-2.96	19.91
A. odoratus	16	2x	1m+7sm	1.54-2.10	14.41

Table 3. Karyomorphological parameters of *Astragalus* species

***A. camptoceras* (2n=16)**					***A. camptoceras* (2n=32)**				
Pair No.	RL	AR	CI	Type	Pair No	RL	AR	CI	Type
I	14.88	1.96	33.70	sm	I	7.96	2.04	32.89	sm
II	13.99	1.76	36.11	sm	II	7.59	1.60	38.32	m
III	13.86	1.55	39.07	m	III	7.55	2.06	32.61	sm
IV	13.05	2.50	28.49	sm	IV	7.10	1.94	33.93	sm
V	12.23	1.89	34.49	sm	V	6.89	2.05	32.77	sm
VI	11.07	2.19	31.32	sm	VI	6.71	2.11	32.09	sm
VII	10.74	1.56	38.93	m	VII	6.66	2.07	32.54	sm
VIII	10.13	2.21	31.14	sm	VIII	6.51	2.05	32.77	sm
***A. campylorhynchus* (2n=16)**					IX	6.10	1.60	38.40	m
Pair No.	RL	AR	CI	Type	X	6.17	2.00	33.25	sm
I	17.01	2.59	27.78	sm	XI	5.82	1.76	36.10	sm
II	14.92	1.61	38.26	m	XII	5.50	1.81	35.53	sm
III	14.40	2.10	32.21	sm	XIII	5.39	1.40	41.66	m
IV	13.93	1.96	33.73	sm	XIV	5.06	1.73	36.54	sm
V	11.40	1.03	49.10	m	XV	4.63	2.00	33.26	sm
VI	9.87	2.07	32.47	sm	XVI	4.27	1.49	40.15	m
VII	9.24	1.50	39.95	m	*A. densifolius* subsp. *densifolius* (2n=16)				
VIII	9.19	1.90	34.38	sm	Pair No.	RL	AR	CI	Type
***A. suberosus* (2n=16)**					I	14.26	1.29	43.62	m
Pair No.	RL	AR	CI	Type	II	13.55	1.29	43.49	m
I	15.07	2.10	32.17	sm	III	13.16	1.16	46.27	m
II	13.86	1.99	33.42	sm	IV	12.87	1.27	44.00	m
III	13.38	2.64	27.45	sm	V	12.58	1.95	33.89	sm
IV	13.19	2.26	30.64	sm	VI	11.89	1.00	49.89	M
V	12.46	2.12	32.03	sm	VII	11.25	1.58	38.63	m
VI	11.57	2.15	31.70	sm	VIII	10.41	1.21	45.17	m
VII	10.96	2.13	31.91	sm	*A. cretaceus* (2n=16)				
VIII	9.47	2.61	27.63	sm	Pair No.	RL	AR	CI	Type
***A. leporinus* var. *hirsutus* (2n=16)**					I	14.61	1.24	44.48	m
Pair No.	RL	AR	CI	Type	II	13.72	1.35	42.38	m
I	15.86	2.54	28.20	sm	III	13.00	1.60	38.40	m

II	14.15	1.85	34.97	sm	IV	12.49	1.29	43.51	m
III	13.53	1.87	34.80	sm	V	12.31	2.03	32.89	sm
IV	12.64	1.53	39.49	m	VI	12.29	1.33	42.88	m
V	12.43	1.37	42.02	m	VII	10.78	1.61	38.26	m
VI	11.68	2.29	30.33	sm	VIII	10.76	2.01	33.16	sm
VII	9.97	2.48	28.70	sm	*A. anthylloides* (2n=16)				
VIII	9.72	2.38	29.56	sm	Pair No.	RL	AR	CI	Type
***A. lamarckii* (2n=32)**					I	14.88	3.10	24.33	sm
Pair No.	RL	AR	CI	Type	II	13.73	1.50	39.96	m
I	7.61	1.76	36.18	sm	III	12.75	1.56	39.05	m
II	7.02	2.12	31.96	sm	IV	12.18	1.57	38.84	m
III	6.95	1.65	37.61	m	V	12.06	1.88	34.63	sm
IV	6.79	1.97	33.65	sm	VI	11.67	2.03	32.94	sm
V	6.55	1.45	40.77	m	VII	11.57	1.43	41.13	m
VI	6.42	1.96	33.76	sm	VIII	11.12	2.09	32.27	sm
VII	6.39	1.54	39.30	m	*A. odoratus* (2n=16)				
VIII	6.20	1.34	42.61	m	Pair No.	RL	AR	CI	Type
IX	6.13	1.89	34.57	sm	I	14.58	1.65	37.71	m
X	6.01	1.57	38.76	m	II	13.72	1.81	35.46	sm
XI	5.94	2.24	30.86	sm	III	12.88	2.07	32.55	sm
XII	5.82	1.56	39.01	m	IV	12.56	1.89	34.49	sm
XIII	5.81	2.07	32.52	sm	V	12.32	2.39	29.42	sm
XIV	5.61	1.96	33.68	sm	VI	11.66	1.94	33.94	sm
XV	5.58	1.41	41.32	m	VII	11.51	2.10	32.24	sm
XVI	5.07	1.29	43.63	m	VIII	10.75	2.01	33.13	sm

RL: Relative legent, AR: Arm ratio, CI: Centromer index

Astragalus odoratus Lam.

A. odoratus belongs to section *Euodmus*. This is a perennial species that grows in marshes, water meadows and waste places between the altitudes of 700 to 1950 m (Chamberlain and Matthews, 1970). The chromosome number and morphology have been determined for the first time by Kurşat et al., (2014). The chromosome number has been detected to be 2n=16. *A. odoratus* has 2 metacentric and 14 sub-metacentric chromosomes. Metaphase chromosome length ranges from 1.54 to 2.10 µm and the ratio of the longest to shortest chromosome is 1.3:1. The chromosome arm ratios have been calculated as 1.65-2.39 µm. The centromeric index ranges from 29.42 µm to 37.71 µm and the relative lengths vary from 10.75 µm to 14.58 µm (Tables 2-3, Figures 1-2).

CONCLUSION

This study has detected the chromosome number and morphology of *A. suberosus, A. leporinus* var. *hirsutus*, *A. lamarckii*, *A. anthylloides* and *A. odoratus* species for the first time. In previous studies conducted on *Astragalus* taxa, the following chromosome numbers were recorded as; *Astragalus gossypinus* 2n = 2x = 14, *Astragalus. meyerei* 2n = 2x = 16, *Astragalus denudatus, Astragalus dschuparensis, Astragalus microcephalus* and *Astragalus hirticalyx* 2n = 4x = 32, *Astragalus brachycalyx* and *Astragalus compactus* 2n = 6x = 48 (Sheidai et al., 2009). The basic chromosome number for *Astragalus* genus ranges from x = 7, 8, 11-15 (Sheidai et al., 2009). It can be determined from the basic chromosome numbers that *Astragalus* species belonging to the genus have very different chromosome numbers and polyploidy. There have been many karyological researches on *Astragalus* species from past to present. According to literature reviews; *Astragalus flavocreatus* I.M. Johnst., 2n=24 (Davina and Gomez-Sosa, 1993), *Astragalus chrysochlorus* Boiss. & Kotschy, 2n=16 (Aytaç, 1997), there are three different chromosome numbers for *Astragalus cicer* L., 2n=32, 48, 64 (Latterell and Townsend, 1994; Pavlova and Kozhuharov, 1993; Zhu and Ohashi, 2000), *Astragalus clarianus* Jeps., 2n=22 (Liston, 1990), *Astragalus coriaceus* Hemsl., n=11 (Spellenberg, 1981), *Astragalus crotalariae* (Benth.) A. Gray,, 2n=24 (Spellenberg, 1981), *Astragalus cruckshanksii* (Hook. & Arn.) Griseb., 2n=28 (Dopchiz et al., 1995). Ranjbar et al., (2011) *Astragalus gilvanensis* Ranjbar & Nouri chromosome number was found as 2n=2x=16 and 2n=4x=32.

Table 4. The values of asymmetry indices (TF%, AsK%, A, Syi, Rec, A1, A2) in the working *Astragalus* taxa.

Taxa	Rec	Syi	TF%	Ask %	A	A_1	A_2
A. camptoceras	83.98	52.06	34.24	65.75	0.03	0.47	0.13
A. camptoceras	78.51	53.71	34.94	65.05	0.01	0.43	0.17
A.campylorhynchus	73.46	54.89	35.44	64.55	0.03	0.42	0.23
A. suberosus	82.94	44.89	30.98	69.01	0.04	0.55	0.14
A. densifolius subsp. *densifolius*	87.65	75.82	43.12	56.87	0.01	0.23	0.10
A. cretaceus	85.55	66.03	39.77	60.22	0.02	0.33	0.10
A. leporinus var. *hirsutus*	78.81	50.67	33.63	66.36	0.04	0.48	0.16
A. lamarckii	82.06	58.17	36.77	63.22	0.01	0.40	0.10
A. anthylloides	83.97	54.32	35.20	64.79	0.03	0.44	0.10
A. odoratus	85.72	50.95	33.75	66.24	0.04	0.49	0.09

Sheidai and Gharemaninejad (2008) have worked on four different species of *Astragalus* (*Astragalus mucronifolius*, *Astragalus cornu-carpae*, *Astragalus crysostachys, Astragalus talimansurensis*). The chromosome number of these species have 2n=2x=16 and the size of chromosomes varied between 0.75 µm in *Astragalus talimansurensis* and 4.00 µm in *Astragalus cornu-carpae*. Konichenko et al. (2014) collected six *Astragalus sericeocanus* populations from different regions of Baykal Lake. The chromosome number was the same 2n = 2x = 16, although there are some differences in the karyotype formula 6m+10sm, 8m+8sm and 4m+12 sm.

In this study, we have identified in *A. camptoceras* type that the number of chromosomes for the diploid as 2n = 2x = 16 and for the tetraploid as 2n = 4x = 32 and for the *A. lamarckii* a tetraploid chromosome number of 2n = 4x = 32 has been recorded. Similarly, the number of chromosomes of *Astragalus effusus* Bunge is 2n = 4x = 32 (Kazem et al., 2010). Konichenko et al., (2014) have concluded that *Astragalus sericeocanus* Gontsch populations from six different regions have the same number of chromosomes, but karyotype formulas are different. These karyotype formulas have been found in the population as 2n = 16=8m+8sm, 2n = 16=6m+10sm and 2n =16=4m+12sm (Konichenko et al., 2014). The karyotype formula obtained from the study shows that the *Astragalus* taxa chromosomes generally had submedian region (sm), median region (m) and rarely median point (M) centromeres (Tables 2-3). In the *A. densifolius* subsp. *densifolius* species one pair of satellite (sat-chromosome) was observed (Figure 1). The chromosome lengths of the species that we studied range from 1.44 to 5.38 µm. The centromeric index varies between 24.33 µm and 49.89 µm, and the relative lengths vary from 4.27 µm to 17.01 µm (Tables 2-3). Whilst the intrachromosomal asymmetry index (A1) varies between 0.23 and 0.55 and the interchromosomal asymmetry index (A2) between 0.09 and 0.23 (Table 4). Among the examined *Astragalus* species; the highest Rec index was 87.65 for *A. densifolius* subsp. *densifolius* while the lowest 73.46 for *A. campylorhynchus*, the highest Syi value was found to be 75.82 for *A. densifolius* subsp. *densifolius* and the lowest was determined as 44.89 for *A. suberosus*, the highest TF% index was found to be 43.12 for *A. densifolius* subsp. *densifolius* while the lowest value was identified to be 30.98 for *A. suberosus*, the highest Ask % was found 69.01 for *A. suberosus* and the lowest value was identified as 56.87 for *A. densifolius* subsp. *densifolius*, It was observed that the A index varies between 0.01 and 0.04 for *Astragallus* species (Table 4).

According to the data of nine taxa belonging to eight different sections, the chromosomal numbers of the two taxa belonging to the *Dassypyllium* section (*A. densifolius* subsp. *densifolius* and *A. cretaceus*) are the same but the karyotype formulas are different. *A. leporinus* var. *hirsutus* belonging to the section *Myobroma* and *A. camptoceras* taxa belonging to section *Oxyglottis*, although they belong to different sections, have the same chromosome number and karyotype. Although the chromosomal numbers are the same, which are close sections *Oxyglottis*, *Harpibolus* and *Platyglottis* each other, the karyotype formulas are different from each other. According to the results of the study, it can be concluded that there is no connection between the karyotype formulas of taxa and whether the sections of taxa are close to each other or in the same section. Similarly, although the chromosomal numbers of *Trigonella strangulata* collected from two different localities were the same, karyotype formulas were found to be different (Martin et al., 2010).

This study concentrated on the analysis of the chromosome numbers and morphologies of nine taxa of the *Astragalus* in Elazığ region. The chromosome numbers and karyotype analysis of the five of the nine taxa have been determined for the first time. This study is expected to make great contribution to the relevant literature.

ANNOTATION

The karyological characteristics of *A. suberosus*, *A. leporinus* var. *hirsutus*, *A. lamarckii*, *A. anthylloides* ve *A. odoratus* taxa were presented as a poster at the 22nd National Biology Congress and published as a summary.

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