

Full Length Research Paper

# Karyotype analyses of the species of the genus *Jurinea* Cass. (Compositae) in Turkey

Bekir Dogan<sup>1\*</sup>, Ahmet Duran<sup>2</sup>, Esra Martin<sup>3</sup> and Erdogan E. Hakki<sup>4</sup>

<sup>1</sup>Selcuk University, Education Faculty, Department of Science Education, Konya, Turkey.

<sup>2</sup>Selcuk University, Education Faculty, Department of Biology Education, Konya, Turkey.

<sup>3</sup>Selcuk University, Education Faculty, Department of Biology Education, Konya, Turkey.

<sup>4</sup>Selcuk University, Faculty of Agriculture, Department of Soil Science and Plant Nutrition, Konya, Turkey.

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In this study, karyotype analyses of 13 species belonging to the genus *Jurinea* Cass. (Compositae) and grown naturally in Turkey were conducted. These taxa include *Jurinea alpigena* C. Koch, *Jurinea ancyrensis* Bornm., *Jurinea aucherana* DC., *Jurinea cadmea* Boiss., *Jurinea cataonica* Boiss. and Hausskn., *Jurinea consanguinea* DC., *Jurinea cypria* Boiss., *Jurinea macrocalathia* C. Koch., *Jurinea macrocephala* DC., *Jurinea mollis* (L.) Reichb., *Jurinea pontica* Hausskn. and Freyn ex Hausskn., *Jurinea pulchella* DC., *Jurinea ramulosa* Boiss. and Hausskn. Karyotype analysis of all the species are introduced to the scientific community for the first time and they were obtained through an image analysis system. The study has made contribution to the cytotaxonomic revision of the genus *Jurinea* in Turkey.

**Key words:** Asteraceae, Image analysis, *Jurinea*, karyotype, Turkey.

## INTRODUCTION

The Asteraceae with its approximately 1,620 genera and more than 23,600 species is the largest family of flowering plants (Stevens, 2001). Asteraceae is widely distributed within diverse regions ranging from southwest of US, Mexico, southern Brazil, South Africa, middle and southwest Asia as well as Australia. South America is accepted to be phylogenetically the geographic origin of the family (Bremer, 1994).

Asteraceae is represented with the largest number of species in the Flora of Turkey with a total number of recorded species being 1209. From these species, 447 are endemic, with an endemism ratio of 37%. With a total number of 134 genera, this family constitutes the second largest family of Turkish flora (Davis et al., 1988; Özhatay and Kültür, 2006).

*Jurinea* Cass. is one of the most important genera within *Asteraceae* and it comprises about 200 species in total (Susanna et al., 2006). Native distribution of *Jurinea*

specifically involved Central Asia, Iran, Turkey, and the Mediterranean basin. The genus *Jurinea* is represented with 18 species within Mediterranean and Irano-Turanian phytogeographic regions of Turkey. Five of these species are endemic to Turkey resulting in an endemism ratio of 27.8% (Danin and Davis, 1975; Dogan, 2007; Dogan et al., 2007; Dogan et al., 2010).

There are cytological studies on the genus *Jurinea* such as Baksay (1956), Blanca and Cueto (1992), Borhidi (1968), Chichirico et al. (1979), Chouksanova et al. (1968), Gagnidze and Gviniashvili (1997), Humphries et al. (1978), Jee et al. (1989), Kieft and Loon (1978), Küpfer (1969a, b), Kuzmanov and Kozuharov (1967), Kuzmanov and Ancev (1973), Kuzmanov and Georgieva (1977), Kuzmanov et al. (1986), Kuzmanov et al. (1990, 1993), Lungeanu (1973), Magulaev (1976, 1982, 1986), Sokolovskaia and Probatova (1980), Vir and Kachroo (1985), Kochjarova (1990), Vogt and Oberprieler (1993) and Dogan et al. (2009).

Karyological knowledge needs to be used in conjunction with other sources of data to achieve a better understanding of the cytological relationships of *Jurinea* species, leading to their natural classification. In this regard, karyotypes were determined in 13 species of

\*Corresponding author. E-mail: [bdogan@selcuk.edu.tr](mailto:bdogan@selcuk.edu.tr). Tel. +90.332 323 8220-5850, +90.505 482 98 57. Fax. +90.332 323 82 25.

**Table 1.** Total, haploid total, relative and mean lengths of metaphase chromosomes of *Jurinea* species studied karyologically.

Chromosome pairs	<i>J. alpigena</i>		<i>J. ancyrensis</i>		<i>J. aucherana</i>		<i>J. cadmea</i>		<i>J. cataonica</i>	
	Total length	Relative sizes (%)	Total length	Relative sizes (%)	Total length	Relative Sizes (%)	Total length	Relative sizes (%)	Total length	Relative sizes (%)
I	1,3700	8,3081	1,6800	8,4380	1.5000	8,1699	1,4600	9,3410	1,3800	7,9861
II	1,3300	8,0655	1,4600	7,3330	1,4100	7,6797	1,2500	7,9974	1,2500	7,2338
III	1,2000	7,2771	1,3700	6,8810	1,3700	7,4619	1,1300	7,2297	1,2000	6,9444
IV	1,1100	6,7314	1,3500	6,7805	1,2500	6,8083	1,0700	6,8458	1,1700	6,7708
V	1,0800	6,5494	1,2900	6,4792	1,2000	6,5359	1,0000	6,3980	1,1100	6,4236
VI	1,0400	6,3069	1,2800	6,4289	1,1300	6,1547	0,9800	6,2700	1,1000	6,3657
VII	1,0000	6,0643	1,2400	6,2280	1,1100	6,0458	0,9600	6,1420	1,0600	6,1343
VIII	0,9500	5,7611	1,2200	6,1276	1,0600	5,7734	0,9400	6,0141	1,0300	5,9606
IX	0,9400	5,7004	1,2000	6,0271	1,0400	5,6645	0,9000	5,7582	1,0000	5,7870
X	0,8900	5,3972	1,1300	5,6755	1,0300	5,6100	0,8600	5,5022	0,9600	5,5556
XI	0,8600	5,2153	1,1100	5,5751	1,0000	5,4466	0,8500	5,4383	0,9400	5,4398
XII	0,8600	5,2153	1,0300	5,1733	0,9800	5,3377	0,7900	5,0544	0,9200	5,3241
XIII	0,8500	5,1546	1,0000	5,0226	0,9400	5,1198	0,7700	4,9264	0,8900	5,1505
XIV	0,8200	4,9727	0,9600	4,8217	0,9000	4,9020	0,7300	4,6704	0,8600	4,9769
XV	0,7700	4,6695	0,9000	4,5203	0,8600	4,6841	0,6900	4,4146	0,8300	4,8032
XVI	0,7300	4,4269	0,8600	4,3194	0,8100	4,4118	0,6500	4,1587	0,8100	4,6875
XVII	0,6900	4,1844	0,8300	4,1688	0,7700	4,1939	0,6000	3,8388	0,7700	4,4560

*Jurinea* growing naturally in Turkey and karyological attributes of selected species were evaluated for the first time.

## MATERIALS AND METHODS

Samples of the genus *Jurinea* were collected from different localities of Turkey, with their akenes, during 2004 to 2006 vegetation periods. Collected samples were maintained as herbarium material at the KNYA and Selcuk University Faculty of Education herbaria (Appendix). For karyotypes, root tips were obtained from seeds germinated for ten days on wet filter paper in petri dishes. Root tips were pretreated with  $\alpha$ -monobromonaphthalene for 16 h at 4°C, fixed in ethanol: glacial acetic acid (3:1) for 24 h and stored at 4°C until use. Root tips were washed in distilled water to remove the fixative, hydrolysed in 1N HCl for 13 min at room temperature and stained in 2% aceto-orcin for 2 h. After staining directly, permanent slides were made with the standard liquid nitrogen method, slides were dried for 24 h at room temperature and mounted in depex. Karyotype analyses were made using Bs200Pro Image analysis software. Measurements were based on ten metaphase plates for each species. Homologous chromosomes were determined according to their total and relative lengths for each species. The total length of the haploid chromosome complements was also determined. Ideograms of each species were sequenced according to their total lengths.

## RESULTS AND DISCUSSION

A chromosome number of  $2n=34$  was reported for all

species (Dogan et al., 2009). In addition to homologous, chromosome pairs were also determined through total and relative length of each chromosome for each species. However, it was impossible to determine the position of centromeres and karyotype formula, because the chromosomes of *Jurinea* species in *Carduinae* subtribe are invariable and very small. The characteristics of somatic chromosomes in the studied species are explained further. The detailed karyological features are presented in Table 1.

### *Jurinea alpigena* C.Koch

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.69 to 1.37  $\mu\text{m}$ . The relative sizes are between 4.18 and 8.30. Total length of the haploid chromosome complement is 16.49  $\mu\text{m}$ . The ideogram of species is shown in Figure 1. Detailed morphological characteristics of chromosome pairs are given in Table 1.

### *Jurinea ancyrensis* Bornm.

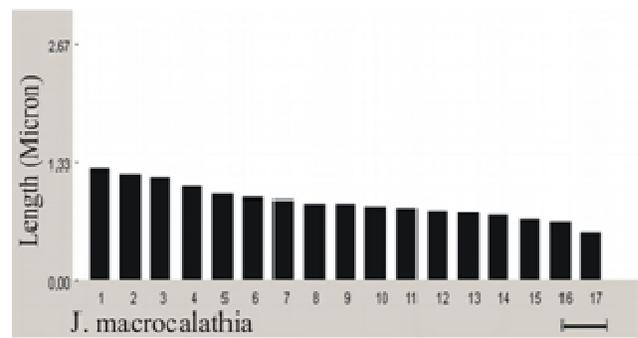
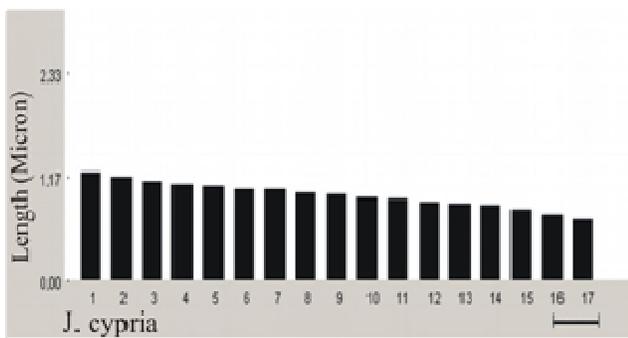
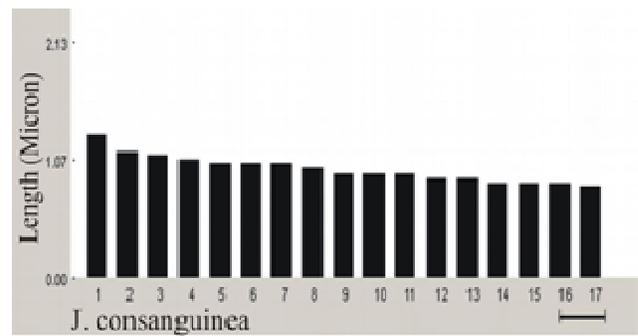
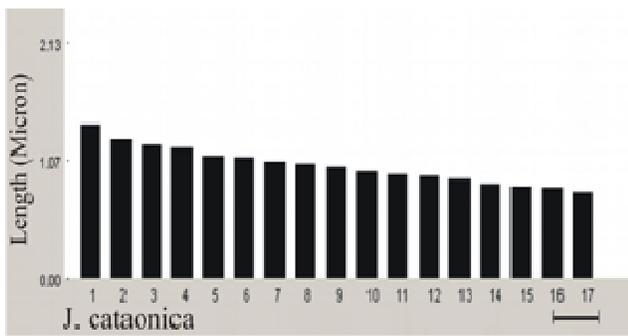
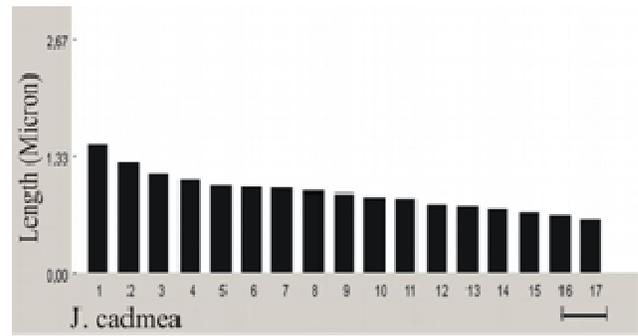
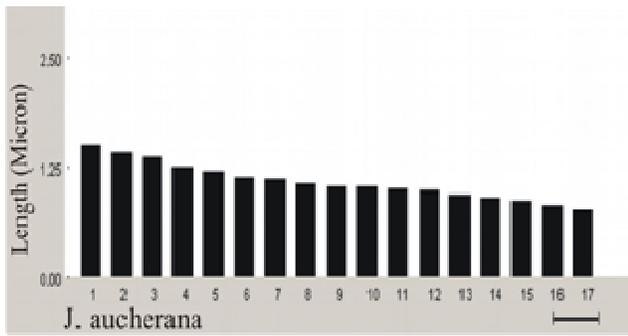
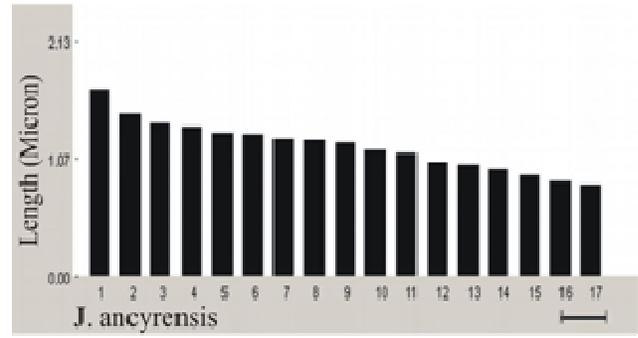
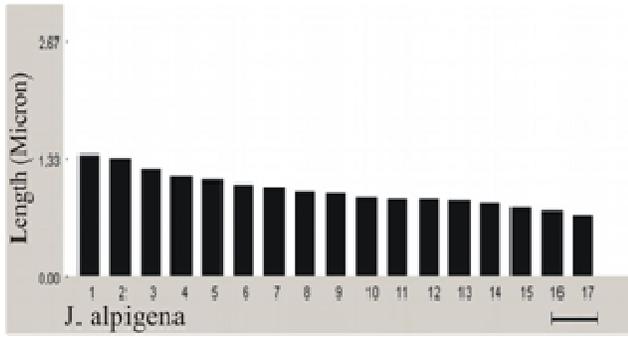
The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.83 to 1.68  $\mu\text{m}$ . The relative sizes are between 4.17 and 8.44. Total length of the haploid chromosome complement

Table 1. (Continued).

Chromosome pairs	<i>J. consanguinea</i>		<i>J. cypria</i>		<i>J. macrocalathia</i>		<i>J. macrocephala</i>		<i>J. mollis</i>	
	Total length	Relative sizes (%)	Total length	Relative Sizes (%)	Total length	Relative sizes (%)	Total length	Relative Sizes (%)	Total length	Relative sizes (%)
I	1,2900	7,7338	1,2200	7,4755	1,2500	8,3167	1,6500	8,4572	1,5600	9,3750
II	1,1300	6,7746	1,1600	7,1078	1,2000	7,9840	1,5400	7,8934	1,3200	7,9327
III	1,1100	6,6547	1,1100	6,8015	1,1600	7,7179	1,4600	7,4833	1,1900	7,1514
IV	1,0700	6,4149	1,0800	6,6176	1,0700	7,1191	1,3500	6,9195	1,1100	6,6707
V	1,0300	6,1751	1,0600	6,4951	0,9700	6,4538	1,3100	6,7145	1,0700	6,4303
VI	1,0300	6,1751	1,0400	6,3755	0,9400	6,2542	1,2900	6,6120	1,0300	6,1899
VII	1,0300	6,1751	1,0300	6,3113	0,9000	5,9880	1,2500	6,4070	0,9600	5,7692
VIII	0,9800	5,8753	0,9800	6,0049	0,8600	5,7219	1,1600	5,9457	0,9400	5,6490
IX	0,9400	5,6355	0,9600	5,8824	0,8600	5,7219	1,1100	5,6894	0,9400	5,6490
X	0,9400	5,6355	0,9400	5,7598	0,8300	5,5223	1,0800	5,5356	0,9000	5,4087
XI	0,9400	5,6355	0,9200	5,6373	0,8100	5,3892	1,0300	5,2793	0,8600	5,1683
XII	0,8900	5,3357	0,8900	5,4534	0,7900	5,2562	1,9800	5,0231	0,8600	5,1683
XIII	0,8900	5,3357	0,8600	5,2696	0,7700	5,1231	1,9400	4,8180	0,8300	4,9880
XIV	0,8600	5,1559	0,8500	5,2083	0,7300	4,8570	1,9200	4,7155	0,8100	4,8678
XV	0,8600	5,1559	0,8000	4,9020	0,6900	4,5908	1,8800	4,5105	0,7900	4,7476
XVI	0,8600	5,1559	0,7300	4,4730	0,6500	4,3247	0,8200	4,2030	0,7700	4,6274
XVII	0,8300	4,9760	0,6900	4,2279	0,5500	3,6593	0,7400	3,7929	0,7000	4,2067

Table 1. (Continued).

Chromosome pairs	<i>J. pontica</i>		<i>J. pulchella</i>		<i>J. ramulosa</i>	
	Total length	Relative sizes (%)	Total length	Relative sizes (%)	Total length	Relative Sizes (%)
I	1,4600	9,1997	1,2900	7,8087	1,5000	8,8080
II	1,3700	8,6326	1,1300	6,8402	1,2500	7,3400
III	1,3500	8,5066	1,1100	6,7191	1,1700	6,8702
IV	1,1300	7,1204	1,0800	6,5375	1,1300	6,6353
V	1,0300	6,4902	1,0600	6,4165	1,1000	6,4592
VI	0,9800	6,1752	1,0400	6,2954	1,0600	6,2243
VII	0,9400	5,9231	1,0300	6,2349	1,0400	6,1069
VIII	0,9000	5,6711	1,0200	6,1743	1,0300	6,0482
IX	0,8600	5,4190	0,9700	5,8717	0,9800	5,7546
X	0,8100	5,1040	0,9400	5,6901	0,9400	5,5197
XI	0,7700	4,8519	0,9200	5,5690	0,9200	5,4022
XII	0,7700	4,8519	0,8900	5,3874	0,8900	5,2261
XIII	0,7400	4,6629	0,8800	5,3269	0,8600	5,0499
XIV	0,7200	4,5369	0,8600	5,2058	0,8300	4,8738
XV	0,7000	4,4108	0,8100	4,9031	0,8100	4,7563
XVI	0,6900	4,3478	0,7700	4,6610	0,7900	4,6389
XVII	0,6500	4,0958	0,7200	4,3584	0,7300	4,2866



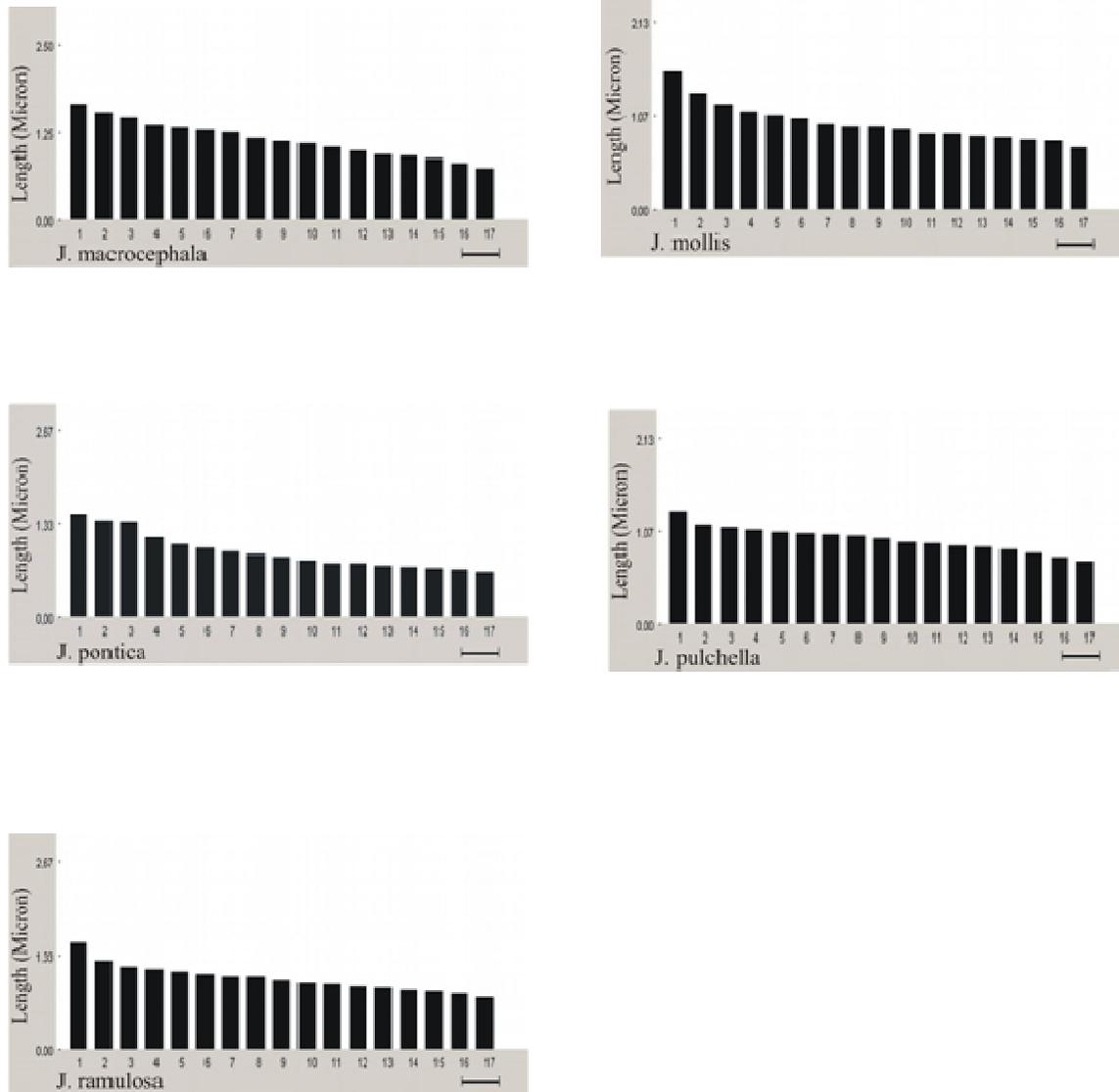


Figure 1. Ideograms of species in Jurinea (Bar:10  $\mu$ m).

is 19.91  $\mu$ m.

#### ***Jurinea aucherana* DC.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.77 to 1.50  $\mu$ m. The relative sizes are between 4.19 and 8.17. Total length of the haploid chromosome complement is 18.36  $\mu$ m.

#### ***Jurinea cadmea* Boiss.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.60 to 1.46  $\mu$ m. The relative sizes are between 3.84 and

9.34. Total length of the haploid chromosome complement is 15.63  $\mu$ m.

#### ***Jurinea cataonica* Boiss. and Hausskn.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.77 to 1.38  $\mu$ m. The relative sizes are between 4.46 and 7.99. Total length of the haploid chromosome complement is 17.28  $\mu$ m.

#### ***Jurinea consanguinea* DC.**

The number of somatic chromosome is  $2n=34$  (Dogan et

al., 2009). The sizes of chromosomes are changed from 0.83 to 1.29  $\mu\text{m}$ . The relative sizes are between 4.98 and 7.73. Total length of the haploid chromosome complement is 16.68  $\mu\text{m}$ .

#### ***Jurinea cypria* Boiss.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.69 to 1.22  $\mu\text{m}$ . The relative sizes are between 4.23 and 7.48. Total length of the haploid chromosome complement is 16.32  $\mu\text{m}$ .

#### ***Jurinea macrocalathia* C. Koch**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.55 to 1.25  $\mu\text{m}$ . The relative sizes are between 3.66 and 8.32. Total length of the haploid chromosome complement is 15.03  $\mu\text{m}$ .

#### ***Jurinea macrocephala* DC.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.74 to 1.65  $\mu\text{m}$ . The relative sizes are between 3.79 and 8.46. Total length of the haploid chromosome complement is 19.51  $\mu\text{m}$ .

#### ***Jurinea mollis* (L.) Reichb.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.70 to 1.56  $\mu\text{m}$ . The relative sizes are between 4.21 and 9.38. Total length of the haploid chromosome complement is 16.64  $\mu\text{m}$ .

#### ***Jurinea pontica* Hausskn. and Freyn ex Hausskn.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.65 to 1.46  $\mu\text{m}$ . The relative sizes are between 4.10 and 9.20. Total length of the haploid chromosome complement is 15.87  $\mu\text{m}$ .

#### ***Jurinea pulchella* DC.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.72 to 1.29  $\mu\text{m}$ . The relative sizes are between 4.36 and 7.81. Total length of the haploid chromosome complement is 16.52  $\mu\text{m}$ .

#### ***Jurinea ramulosa* Boiss. and Hausskn.**

The number of somatic chromosome is  $2n=34$  (Dogan et al., 2009). The sizes of chromosomes are changed from 0.73 to 1.50  $\mu\text{m}$ . The relative sizes are between 4.29 and 8.80. Total length of the haploid chromosome complement is 17.03  $\mu\text{m}$ .

### **Conclusion**

According to the information in this study, only one study has been carried out on the chromosome number of the *Jurinea* species from Turkey (Dogan et al., 2009). In all of the species in the genus *Jurinea* examined, the somatic chromosome number were observed as  $2n=34$  again. These findings are in agreement with the somatic chromosome numbers given for the *Jurinea* genus species in the previous research (Dogan et al., 2009). In this study, the karyotypes of the 13 species studied first were determined by Image analysis system belonging to the genus *Jurinea*. Ideograms of these species were arranged in order of decreasing lengths. Centromers and the type of chromosomes could not be determined, because the chromosomes of these species are very small. Karyotyping was not possible for the species *Jurinea kileae*, *Jurinea brevicaulis* and *Jurinea stoechadifolia* due to the fact that, we were unable to germinate the achenes of these species.

The chromosome morphologies of the genus *Jurinea* species studied are slightly different from each other. The length of the smallest chromosome was 0.55  $\mu\text{m}$  and found in *J. macrocalathia*. The length of the largest chromosome was 1.65  $\mu\text{m}$  and found in *J. macrocephala*. The smallest relative length (3.66) in *J. macrocalathia* and the largest arm ratio (9.38) in *J. mollis* were observed. According to the mean length, *J. macrocalathia* species has the smallest (0.44  $\mu\text{m}$ ) and *J. ancyrensis* species had the largest (0.59  $\mu\text{m}$ ) mean length values. The total haploid chromosome length is the shortest in *J. macrocalathia* (15.03  $\mu\text{m}$ ) and the longest in *J. ancyrensis* (19.91  $\mu\text{m}$ ).

In general, *Jurinea* presents low level of variation in chromosome number, with  $2n=34$  in most of the species. Some species of *Jurinea* are diploids, with  $2n=24$ , 30, 32, 35, 36 and 58 (Missouri Botanical Garden, <http://mobot.mobot.org/W3T/Search/ipcn.html> and Index to Chromosome numbers in the Asteraceae, <http://www-asteraceae.cla.kobe-u.ac.jp/index.html>). From the *Jurinea* species that are naturally grown in Turkey, only *J. mollis* was previously studied by different research groups and its somatic chromosome number was reported as  $2n=30$ , 34, 35 and 36 (Missouri Botanical Garden, <http://mobot.mobot.org/W3T/Search/ipcn.html> and Index to Chromosome numbers in the Asteraceae; <http://www-asteraceae.cla.kobe-u.ac.jp/index.html>; Dogan et al., 2009).

The present study determined the karyotypes of *Jurinea* species growing naturally in Turkey. We believe this study will play a positive role on shedding light on this taxonomically complex genus with morphologically unsolved problems.

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## APPENDIX

### Locality information for the studied species

*Jurinea consanguinea* – Turkey: B3 Konya: Sultan Daglari, North of Hidirlik dag hotel, 1130 m, 37°14.913'N, 038°49.427'E, 18.07.2006, BD 1001; *J. alpigena* – Turkey: A4 Karabuk: Yenice, Keltepe, 1630 to 1680 m, 41°03.796'N, 032°27.781'E, 21.07.2006, BD 1510; *J. cadmea* - Turkey: B2 İzmir: Odemis, Bozdag, 1650-1750 m, 38°20.671'N, 028°06.403'E, 19.07.2006, BD 1503; *J. mollis* – Turkey: A1 Kizilirmak: 1 km after the cross-road for Vize-Sergen, *Quercus* sp. forest, 310 to 320 m, 41°37.312'N, 027°40.950'E, 07.07.2005, BD 1504; *J. macrocalathia* – Turkey: A1 Tekirdag: Malkara, North of Kumbag, 5-25 m, 40°51.852'N, 027°27.604'E, BD 1507; *J. pontica* – Turkey: A3 Kocaeli: Esmek, 500 m before the signboard of the Sakarya province, 40-50 m, 40°44.118'N, 033°36.871'N, 09.07.2005, BD 1011; *J. pulchella* – Turkey: A9 Van: Yuzuncu Yil University campus, around the heating center, 1650 m, 05.08.2005,

BD 1025; *J. cypria* – Turkey: C4 Mersin: Mut, plateau of Kozlar, edge of Ayı stream, 1330 m, 30.08.2006, BD 1521; *J. macrocephala* – Turkey: C5 Konya: Halkapinar, Aydos mountain, Kayasaray village, 1 km East of Karasirt, 1700 m, 37° 22.249'N, 034°17.308'E, 31.07.2005, BD 1017; *J. aucherana* – Turkey: B7 Erzincan: Old Cayirli road, 1-1.5 km apart from Botas petroleum pipeline, slopes of the hill on the left, 1760 to 2095 m, 39°53.429'N, 039°45.778'E, 22.08.2006, BD 1519; *J. ramulosa* – Turkey: C6 Kahramanmaraş: Ahirdagi, 1390 m, 37°37.057'N, 036°52.074'E, BD 1513; *J. cataonica* – Turkey: B7 Erzincan: Old Cayirli road, 10 km, slopes aside the road, 1750 m, 39°47.954' N, 039°30.343' E, 07.08.2005, BD 1029; *J. ancyrensis* – Turkey: B7 Elazig: Keban, Keban-Agli road, 3th km, on the slopes, 800 to 850 m, 38°48.692'N, 038°43.929'E, 21.08.2006, BD 1516.