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A karyological study on taxa of *Coronopus* D.C. section of *Plantago* L. genus (Plantaginaceae) in Turkey

Bahattin Bozdağ^a, Hakan Sepet^b and Canan Özdemir^{a*}

^aBiology Department, Celal Bayar University, Science and Art Faculty, Manisa, Turkey; ^bEnvironmental Engineering Department, Ahi Evran University, Engineering-Architecture Faculty, Kırşehir, Turkey

In this study the chromosome number and morphology of five taxa of the *Coronopus* D.C. section – *Plantago coronopus* subsp. *coronopus* L., *P. coronopus* subsp. *commutata* (GUSS.) PILGER, *P. crassifolia* FORSSKAL, *P. maritima* L., and *P. holosteam* SCOP. (Plantaginaceae) – in Turkey were investigated using karyological techniques. The seeds of taxa were collected from natural habitats. The chromosome numbers are determined for four taxa (*P. coronopus* subsp. *coronopus*, *P. coronopus* subsp. *commutata*, *P. crassifolia* and *P. maritima*) as $2n = 4x = 20$ and one taxon (*P. holosteam*) as $2n = 2x = 12$. The chromosome numbers and karyotype analysis of the species are reported for the first time for Turkey.

Keywords: chromosome number; karyology; *Plantago*

Introduction

The genus *Plantago* L. includes 483 species distributed around the world (Tutel et al. 2005). There are two subgenera, *Euplantago* and *Psyllium*. The *Psyllium* subgenus contains only the *Psyllium* section, but the *Euplantago* subgenus has 18 sections (Pilger 1937). There are nine sections, 21 species and 23 taxa of *Plantago* in Turkey according to the *Flora of Turkey* (Tutel 1971, 1982, 1993; Davis 1982, 1988; Güner et al. 2000). The genus *Plantago* has a tribasic chromosome number, $x = 4, 5$ and 6 , where $x = 6$ is the primary base number and the others are considered to be secondary differentiations of it (Dhar and Sharma 1999). The basic number of $x = 5$ is found in sect. *Leucopsyllium* and sect. *Coronopus*.

Polyploidy is common in *Plantago*: roughly two-thirds of *Plantago* species for which chromosome have been counted are polyploid. According to some studies polyploidy does not play a large role in differentiation (Briggs 1973; Rahn 1996), except for sect. *Oliganthos* from subgenus *Plantago* (Rahn 1984). In contrast, Ishikawa et al. (2009) said that the all *Plantago* subgenera have a history of allopolyploidy.

Plantaginaceae has eight sections in Turkey. The *Coronopus* D.C. section contains five taxa (*Plantago coronopus* subsp. *coronopus* L., *Plantago coronopus* subsp. *commutata* (GUSS.) PILGER, *Plantago crassifolia* FORSSKAL, *Plantago maritima* L. and *Plantago holosteam* SCOP.) in Turkey. In this study, we aim to characterize the karyology of these taxa. To date the only studies of these taxa available in the literature are reports of their chromosome numbers (Gregor 1939; Moore 1976; Dalgaard 1989; Mohsenzadeh et al. 2008).

Materials and methods

Plant materials were collected from the localities detailed in Table 1. Voucher specimens are deposited in the herbarium of the Department of Biology at Celal Bayar University. The taxonomical nomenclatures adopted here follow Davis (1982). We used root tips to count chromosome numbers.

For the study of somatic chromosomes, root tips were obtained from germinated seeds in sterilized Petri dishes. They were pre-treated in α -monobromonaphthalene (16 h) and then fixed in a mixture of ethanol and acetic acid (24 h). Root tips were hydrolyzed with 1 N HCl at 60°C for 15 min, stained in Feulgen reagent for 1 h in darkness, and finally squashed in 45% acetic acid (Elçi 1994). Chromosome measurements were based on five metaphase plates. Slides were examined under a Leica DM 3000 LB photomicroscope (Leica Microsystems, Wetzlar, Germany) and photographs were taken with the same microscope. The karyograms were drawn from 10 mitotic metaphases. Chromosome nomenclature was carried out according to the method described by Levan et al. (1964).

Results

P. coronopus subsp. *coronopus*

The chromosome number of this taxon is determined as $2n = 4x = 20$ and basic number as $x = 5$. This taxon consists of one pair of median (M) (4th), two pairs of submedian (sm) (7th and 9th) and seven pairs of median region (m) (1st, 2nd, 3rd, 5th, 6th, 8th and 10th) chromosomes according to centromere position. Satellites were not observed this taxon. Chromosome sizes were 1.83 and 4.25 μm . The longest and shortest arm sizes

*Corresponding author. Email: cozdemir13@gmail.com

Table 1. Localities of investigated *Plantago* species used for karyological studies.

Species	Locality	Specimen number
<i>P. coronopus</i> subsp. <i>coronopus</i>	İzmir, Aliağa, back beach area, sea level, 18 May 2012	BBOZDAG 1150
<i>P. coronopus</i> subsp. <i>commutata</i>	İzmir, Gümüldür, near forest camping, sea level, 25 May 2012	BBOZDAG 1170
<i>P. crassifolia</i>	İzmir, Çeşme, sea level, 22 June 2012	BBOZDAG 1250
<i>P. maritima</i>	İzmir, Çeşme, sea level, 22 June 2012	BBOZDAG 1260
<i>P. holosteuum</i>	Kütahya, Murat Mounth, Kesiksöğüt area, 30 June 2012	BBOZDAG 1280

were 2.33 and 0.75 μm , respectively. Total chromosome size was determined as 25.78 μm (Figures 1A, B, 2A, Table 2).

P. coronopus subsp. *commutata*

The chromosome number of this taxon is determined as $2n = 4x = 20$ and basic number as $x = 5$. According to the karyotype analysis, taxon has two pairs of median (M) (1st and 10th), three pairs of submedian (sm) (2nd, 4th and 7th) and five pairs of median region (m) (3rd, 5th, 6th, 8th and 9th) chromosomes. Satellites were not observed. Chromosome sizes were 2.00 and 4.00 μm . The longest and shortest arm sizes were 2.00 and 1.00 μm , respectively. Total chromosome size was determined as 26.07 μm (Figures 1C, D, 2B, Table 3).

P. crassifolia

The chromosome number of this species is determined as $2n = 4x = 20$ and the basic number as $x = 5$. The karyotype of this species consists of nine pairs of median region (m), and one pair of median (M) chromosomes. The centromeres of the 1st, 2nd, 3rd, 4th, 6th, 7th, 8th, 9th and 10th chromosomes are at the median region (m); the 5th chromosomes are at the median (M). No satellites were observed in the karyotype of this species. Chromosome sizes vary from 2.37 to 4.66 μm . The longest arm is 2.78 μm and the shortest arm is 1.00 μm (Figures 1E, F, 2C, Table 4).

P. maritima

The chromosome number of this species is determined as $2n = 4x = 20$ and the basic number as $x = 5$. The karyotype of this species consists of nine pairs of median region (m), and one pair of median (M) chromosomes. The centromeres of the 1st, 2nd, 3rd, 4th, 5th, 6th, 7th, 9th and 10th chromosomes are at the median region (m); and of the 8th chromosomes are at the median (M). No satellites were observed in the karyotype of this species. Chromosome sizes vary from 2.40 to 5.18 μm . The longest arm is 3.03 μm and the shortest arm is 0.98 μm (Figures 1G, H, 2D, Table 5).

P. holosteuum

The chromosome number of this species is determined as $2n = 2x = 12$ and basic number as $x = 6$. According

to the karyotype analysis, this taxon has one pair of median (M) (4th), two pairs of submedian (sm) (5th and 6th) and three pairs of median region (m) (1st, 2nd and 3rd) chromosomes. Satellites were not observed. The chromosome sizes were 2.17 and 4.08 μm . The longest and shortest arm sizes were 2.33 and 0.59 μm , respectively. The total chromosome size was determined as 18.66 μm (Figures 1I, J, 2E, Table 6).

Discussion

In this study, we determined chromosome numbers and detailed measurements of taxa of *Coronopus* section of the genus *Plantago* in Turkey. No previous studies have been performed on the chromosomes except for determination of the chromosome numbers of these species. We found that four tetraploid taxa (*P. coronopus* subsp. *coronopus*, *P. coronopus* subsp. *commutata*, *P. crassifolia*, and *P. maritima*) have chromosome numbers of $2n = 4x = 20$ and a basic number of $x = 5$. *P. holosteuum* has $2n = 2x = 12$ and $x = 6$. Taxa have three different chromosome types – median (M), submedian (sm) and median region (m) – according to centromere position. We did not observe satellites in any investigated taxa. Variation was found in total chromosome size, short and long arm size, and chromosome arm ratios among the taxa. The longest chromosome was determined in *P. maritima* as 5.18 μm and the shortest chromosome was determined in *P. coronopus* subsp. *coronopus* as 1.83 μm .

According to one of the few studies, *P. crassifolia* has $2n = 24$ and *P. maritima* group the numbers $2n = 12$ and 24 chromosome number (Gregor 1939). In another study, the chromosome number of *P. maritima* L. subsp. *borealis* (Lange) Blytt & Dahl was determined as $2n = 12$ (Dalgaard 1989). According to these studies, these plants have $x = 6$ as a basic number, which is different from our results. We determined the chromosome number of *P. crassifolia* and *P. maritima* to be $2n = 20$ and the basic number $x = 5$.

The chromosome numbers of *P. coronopus* subsp. *commutata* and *P. coronopus* subsp. *coronopus* were determined as $2n = 20$ and $2n = 10$, respectively (Moore 1976). In another study from Iran, the chromosome numbers of *P. coronopus* subsp. *commutata* and *P. coronopus* subsp. *coronopus* were determined as $2n = 10$ and $2n = 20$, respectively (Mohsenzadeh et al. 2008). The basic

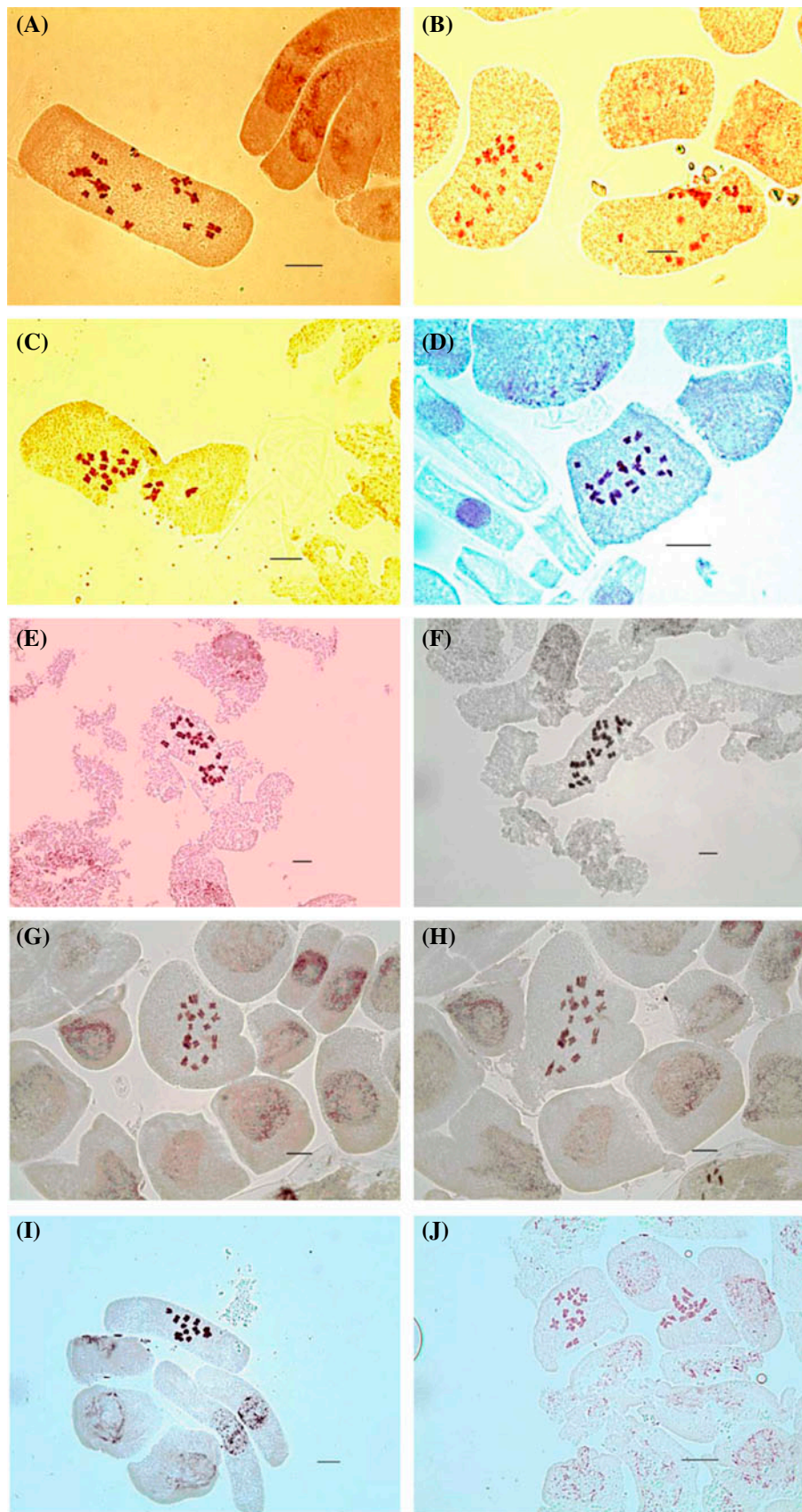


Figure 1. Microphotographs of somatic metaphases of taxa of *Coronopus* section. (A, B) *P. coronopus* subsp. *coronopus* ($2n = 20$); (C, D) *P. coronopus* subsp. *commutata* ($2n = 20$); (E, F) *P. crassifolia* ($2n = 20$); (G, H) *P. maritima* ($2n = 20$); (I, J) *P. holosteum* ($2n = 12$). Scale bars: 10 μm .

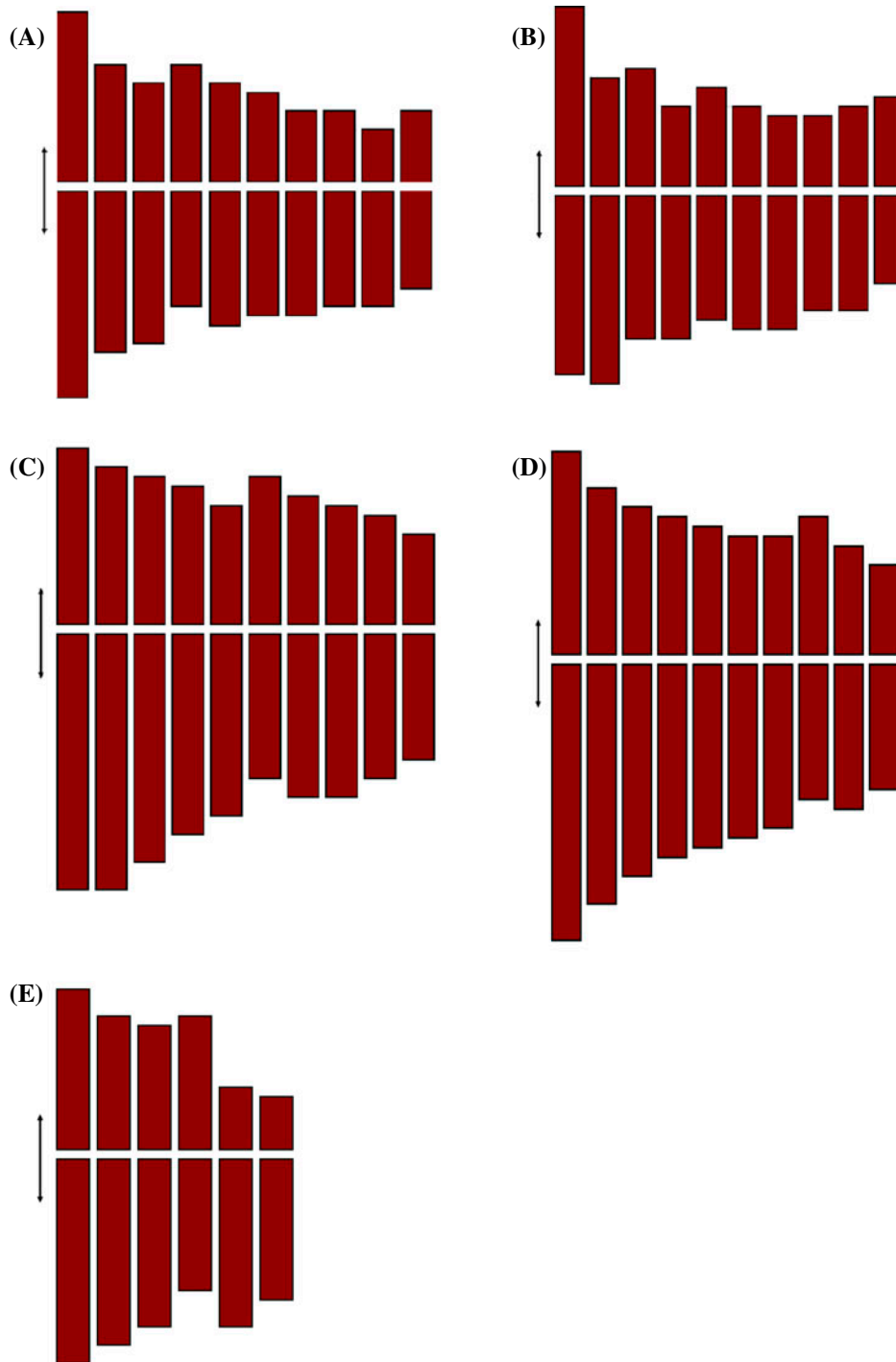


Figure 2. Haploid idiograms of taxa. (A) *P. coronopus* subsp. *coronopus* ($2n = 20$); (B) *P. coronopus* subsp. *commutata* ($2n = 20$); (C) *P. crassifolia* ($2n = 20$); (D) *P. maritima* ($2n = 20$); (E) *P. holosteum* ($2n = 12$). Scale bars: 1 μm .

number of these plant samples is $x = 5$. In this study, we determined the chromosome number of these taxa to be $2n = 20$ and basic number to be $x = 5$.

There are many different studies of the chromosome number in *Plantago* species. Roughly 75% of the studied species have $x = 6$ as a base number, and the remaining 25% have $x = 5$ (Rahn 1957, 1996). Badr (1999) explained that evolution in *Plantago* has involved a reduction in the nuclear DNA content with a decrease in the

number of chromosomes from $x = 6$ to $x = 5$ to $x = 4$. Turkey (*P. coronopus* subsp. *commutata*, *P. coronopus* subsp. *coronopus*, *P. crassifolia* and *P. maritima*) with the basic number of $x = 5$ evolved before *P. holosteum*. *P. holosteum* has a basic chromosome number of $x = 6$. The rate of evolution of this taxon is progressing more slowly than other *Coronopus* taxa in Turkey.

This study presents the chromosome number of *Coronopus* sect. in Turkey. The chromosome numbers

Table 2. Parameters of mitotic metaphase chromosomes of *P. coronopus* subsp. *coronopus*.

Cn	C (µm)	L (µm)	S (µm)	R	I (µm)	RS	CP
1	4.25	2.33	1.92	1.21	45.17	16.48	Median region (m)
2	3.08	1.83	1.25	1.46	40.58	11.94	Median region (m)
3	2.75	1.66	1.09	1.52	39.63	10.66	Median region (m)
4	2.66	1.33	1.33	1.00	50.00	10.31	Median (M)
5	2.58	1.50	1.08	1.38	41.86	10.01	Median region (m)
6	2.42	1.42	1.00	1.42	41.32	9.38	Median region (m)
7	2.16	1.41	0.75	1.88	34.72	8.38	Submedian (sm)
8	2.13	1.30	0.83	1.56	38.96	8.26	Median region (m)
9	1.92	1.32	0.60	2.20	31.25	7.45	Submedian (sm)
10	1.83	1.08	0.75	1.44	40.98	7.10	Median region (m)

Total chromosome size: 25.78 µm.

Abbreviations: Cn, chromosome number; C, total chromosome length; L, long arm length; S, short arm length; R, arm ratio = L/S; I, centromeric index = (S/C) × 100; RS, relative size; CP, centromeric position.

Table 3. Parameters of mitotic metaphase chromosomes of *P. coronopus* subsp. *commutate*.

Cn	C (µm)	L (µm)	S (µm)	R	I (µm)	RS	CP
1	4.00	2.00	2.00	1.00	50.00	15.34	Median (M)
2	3.25	2.10	1.15	1.82	35.38	12.46	Sub-median (sm)
3	2.83	1.58	1.25	1.26	44.16	10.85	Median region (m)
4	2.50	1.58	0.92	1.72	36.80	9.59	Sub-median (sm)
5	2.50	1.42	1.08	1.31	43.20	9.59	Median region (m)
6	2.42	1.50	0.92	1.63	38.01	9.28	Median region (m)
7	2.25	1.50	0.75	2.00	33.33	8.63	Sub-median (sm)
8	2.16	1.33	0.83	1.60	38.42	8.28	Median region (m)
9	2.16	1.25	0.91	1.37	42.13	8.28	Median region (m)
10	2.00	1.00	1.00	1.00	50.00	7.67	Median (M)

Total chromosome size: 26.07 µm.

Abbreviations: Cn, chromosome number; C, total chromosome length; L, long arm length; S, short arm length; R, arm ratio = L/S; I, centromeric index = (S/C) × 100; RS, relative size; CP, centromeric position.

Table 4. Parameters of mitotic metaphase chromosomes of *P. crassifolia*.

Cn	C (µm)	L (µm)	S (µm)	R	I (µm)	RS	CP
1	4.66	2.78	1.88	1.48	40.34	13.33	Median region (m)
2	4.44	2.75	1.69	1.63	38.06	12.70	Median region (m)
3	4.13	2.50	1.63	1.53	39.46	11.81	Median region (m)
4	3.70	2.20	1.50	1.47	40.54	10.58	Median region (m)
5	3.34	2.03	1.31	1.55	39.22	9.55	Median (M)
6	3.26	1.63	1.63	1.00	50.00	9.32	Median region (m)
7	3.22	1.84	1.38	1.33	42.86	9.21	Median region (m)
8	3.03	1.78	1.25	1.42	41.25	8.67	Median region (m)
9	2.81	1.62	1.19	1.36	42.35	8.03	Median region (m)
10	2.37	1.37	1.00	1.37	42.20	6.78	Median region (m)

Total chromosome size: 34.96 µm.

Abbreviations: Cn, chromosome number; C, total chromosome length; L, long arm length; S, short arm length; R, arm ratio = L/S; I, centromeric index = (S/C) × 100; RS, relative size; CP, centromeric position.

Table 5. Parameters of mitotic metaphase chromosomes of *P. maritime*.

Cn	C (µm)	L (µm)	S (µm)	R	I (µm)	RS	CP
1	5.18	3.03	2.15	1.41	41.50	14.96	Median region (m)
2	4.35	2.60	1.75	1.48	40.23	12.56	Median region (m)
3	3.88	2.25	1.63	1.38	42.01	11.21	Median region (m)
4	3.55	2.08	1.47	1.41	41.41	10.25	Median region (m)
5	3.38	2.00	1.38	1.45	40.83	9.76	Median region (m)
6	3.15	1.88	1.27	1.48	40.32	9.10	Median region (m)
7	3.00	1.75	1.25	1.40	41.66	8.66	Median region (m)
8	3.00	1.50	1.50	1.00	50.00	8.66	Median (M)
9	2.73	1.55	1.18	1.31	43.22	7.88	Median region (m)
10	2.40	1.42	0.98	1.45	40.83	6.93	Median region (m)

Total chromosome size: 34.62 µm.

Abbreviations: Cn, chromosome number; C, total chromosome length; L, long arm length; S, short arm length; R, arm ratio = L/S; I, centromeric index = (S/C) × 100; RS, relative size; CP, centromeric position.

Table 6. Parameters of mitotic metaphase chromosomes of *P. holosteum*.

Cn	C (µm)	L (µm)	S (µm)	R	I (µm)	RS	CP
1	4.08	2.33	1.75	1.33	42.89	21.86	Median region (m)
2	3.58	2.08	1.50	1.38	41.90	19.18	Median region (m)
3	3.33	1.92	1.41	1.36	42.34	17.84	Median region (m)
4	3.00	1.50	1.50	1.00	50.00	16.07	Median (M)
5	2.50	1.85	0.67	2.76	26.80	13.39	Submedian (sm)
6	2.17	1.58	0.59	2.68	27.19	11.63	Submedian (sm)
Total chromosome size: 18.66 µm.							

Abbreviations: Cn, chromosome number; C, total chromosome length; L, long arm length; S, short arm length; R, arm ratio = L/S; I, centromeric index = (S/C) × 100; RS, relative size; CP, centromeric position.

of four taxa were determined as $2n = 20$ and one taxon was determined as $2n = 12$; also idiograms and karyograms of these taxa are given here for the first time.

Disclosure statement

No potential conflict of interest was reported by the authors.

References

- Badr SF. 1999. Relationships of some *Plantago* species. *Taekholmia*. 19(1):27–36.
- Briggs BG. 1973. Chromosomal studies on *Plantago* in Australia. *Contr NSW Natl Herbar*. 4:399–405.
- Dalgaard V. 1989. Additional chromosome numbers in vascular plants from the Disko Bugt Area (West Greenland). *Willdenowia*. 19(1):199–213.
- Davis PH. 1982. Flora of Turkey and the East Aegean Islands. Vol. 7. Edinburgh: Edinburgh University Press.
- Davis PH. 1988. Flora of Turkey and the East Aegean Islands. Aegean Islands (Supplement). Vol. 10. Edinburgh: Edinburgh University Press.
- Dhar MK, Sharma PK. 1999. Genetic diversity in genus *Plantago*. In: Kachroo P, editor. *Progress in cytogenetics*. Bishen Singh Mahendra Pal Singh: Dehradun, India.
- Elçi Ş. 1994. Sitogenetikte Araştırma Yöntemleri ve Gözlemler. 100. Yıl Üniversitesi Yayınları. No: 18 Fen Edebiyat Fak. Yayın No: 16. Van.
- Gregor JW. 1939. Experimental taxonomy. IV. Population differentiation in North American and European Sea Plantains allied to *Plantago maritima* L. *New Phytol*. 38(4):293–322.
- Güner A, Özhatay N, Ekim T, Başer KHC. 2000. Flora of Turkey and the East Aegean Islands. Vol. 11. Edinburgh: Edinburgh University Press.
- Ishikawa N, Yokoyama J, Tsukaya H. 2009. Molecular evidence of reticulate evolution in the subgenus *Plantago* (Plantaginaceae). *Am J Bot*. 96(9):1627–1635.
- Levan A, Fredga K, Sandberg AA. 1964. Nomenclature for centromeric position on chromosomes. *Hereditas*. 52(2):201–220.
- Mohsenzadeh S, Nazeri V, Mirtadzadini SM. 2008. Chromosome numbers of fifteen species of *Plantago* L. (Plantaginaceae) from Iran. *Iran J Bot*. 14(1):47–53.
- Moore DM. 1976. Plantaginaceae in Tutin et al. *Flora Europaea*. Vol. 4. Cambridge: Cambridge University Press. p. 38–44.
- Pilger R. 1937. Plantaginaceae. In: Engler A, editor. *Pflanzenreich*. Berlin: H.R. Engelmann; p. 1–466.
- Rahn K. 1957. Chromosome numbers in *Plantago*. *Botanisk Tidsskrift*. 53:369–378.
- Rahn K. 1984. *Plantago* sect. *Oliganthos* in southern South America, a taxonomic revision. *Nord J Bot*. 4(5):601–627.
- Rahn K. 1996. A phylogenetic study of the Plantaginaceae. *Bot J Linn Soc*. 120(2):145–198.
- Tutel B. 1971. Taksonomik karakterler ve değerlendirilmeleri. *Türk Biyoloji Dergisi*. 2:74–81.
- Tutel B. 1982. *Plantago* L. In: Davis PH, editor. *Flora of Turkey and the East Aegean Islands*. Vol. 7. Edinburgh: Edinburgh University Press; p. 504–521.
- Tutel B. 1993. Türkiye Florası Atlası (Atlas Flora Turcicae) *Plantago*. 5–7. İ. Ü. Yay. 3689 Fen Fak. 225.
- Tutel B, Kandemir I, Kus S, Kence A. 2005. Classification of Turkish *Plantago* L. species using numerical taxonomy. *Turk J Bot*. 29(2005):51–61.