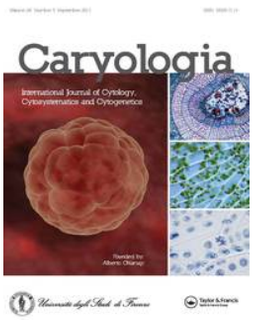
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Chromosome counts of *Tragopogon* L. (Asteraceae) from Turkey

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In the present study, mitotic chromosome numbers of 18 *Tragopogon* taxa from Turkey, including five endemic species, were counted. The plant material originates from 30 populations. The chromosome numbers of *T. albinervis* ($2n = 12$), *T. dshimilensis* ($2n = 12$), *T. oligolepis* ($2n = 12$), *T. porrifolius* subsp. *abbreviatus* ($2n = 12$) and *T. subacaulis* ($2n = 12$) are reported for the first time. The chromosome numbers are published for the first time from Turkish accessions, except for *T. coloratus*, *T. latifolius* var. *latifolius*, *T. reticulatus*, and *T. porrifolius* subsp. *longirostris*. Of the studied plants 13 taxa proved to be diploid ($2n = 12$) and five taxa tetraploid ($2n = 24$). The chromosome numbers obtained from the present study are consistent with previous reports.

Keywords: chromosome number; *Tragopogon*; Turkey

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Introduction

Tragopogon L. (Asteraceae) comprises nearly 150 species mostly distributed in Europe and Asia (Bremer 1994; Soltis et al. 2004). It is one of the largest genera of subtribe Scorzonerinae Dumort. (Mavrodiev et al. 2004) and is characterized by entire, parallel-veined leaves, one rowed involucral bracts, and beaked achenes. It is almost impossible to correctly identify *Tragopogon* taxa without adequate knowledge of mature achenes and color of ligules (Borisova 1964; Matthews 1975).

Tragopogon is represented by 79 species in Flora of USSR (Borisova 1964), 37 species in Flora Iranica (Rechinger 1977), and 20 species in Flora of Europe (Richardson 1976). According to Matthews (1975), *Tragopogon* is represented by 18 species in Turkey, but this number reaches 25 together with doubtfully recorded and recently described taxa (Coşkunçelebi and Gültepe 2012). Seven of these taxa are endemic to Turkey and the endemism rate is 33%.

Tragopogon is one of the most complicated plant genera with a base chromosome number of $x = 6$ (Ownbey and McCollum 1954; Mavrodiev, Tancig et al. 2008). The taxonomic difficulties are caused by the high morphological variation originating from hybridization and presence of different ploidy levels (Ownbey 1950; Mavrodiev, Tancig et al. 2008; Bell et al. 2012). Although the majority of *Tragopogon* taxa are diploids, several polyploids and/or polyploid cytotypes were also recorded within the genus (Nazarova 1991; Soltis et al. 2004; Mavrodiev, Tancig et al. 2008). One of the earliest studies related to *Tragopogon* chromosome numbers was conducted by Poddubnaja-Arnoldi et al. (1935). They reported that the chromosome numbers of *T. brevirostris* DC., *T. dubius* Scop., *T. marginatus* Boiss. & Bushe, and *T. porrifolius* L. are $2n = 2x = 12$ and of *T. cupani* Guss. ex DC. is $2n = 4x = 24$. After the first chromosome records, Winge (1938) investigated the cytogenetic relationships between *T. porrifolius* and *T. pratensis* L. Ownbey (1950) confirmed the diploid chromosome number ($2n = 2x = 12$) in *T. dubius*, *T. pratensis*, and *T. porrifolius* and reported tetraploid chromosome number ($2n = 4x = 24$) in *T. mirus* Ownbey and *T. miscellus* Ownbey. Wilson (1983) carried out a comprehensive cytological study on 27 species of *Tragopogon* from different countries. *Tragopogon coloratus* C.A. Mey., *T. latifolius* Boiss. var. *latifolius*, and *T. reticulatus* Boiss. & A. Huet in Wilson's (1983) study were gathered from Turkey and the chromosome numbers were reported as $2n = 2x = 12$, $2n = 4x = 24$, and $2n = 2x = 12$, respectively. In addition, the chromosome number of *T. longirostris* Sch. Bip. var. *longirostris* from Turkey was given as $2n = 2x = 12$ by Öztürk et al. (2009).

Chromosome number is an important character for plant evolutionary studies and may provide information on polyploidy and other genome changes (Guerra 2008; Louzada et al. 2010). Chromosome reports from wild populations are important to determine the chromosome number (Stace, 2000). At the same time, counting should be based on several cells from different wild populations to remove abnormal chromosome numbers (Favarger 1978; Stace 2000). In addition, documentation of chromosome number is a priority for the conservation of the world's plant genetic resources (Stace 2000). To date, chromosome number data of only about 25% of flowering plants have been determined (Stace 2000; Garbari et al. 2012). Additionally, in spite of the great

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floristic richness of Turkey, only 15% of the vascular plant taxa have been investigated in terms of chromosome number (Davis et al. 1988; Güner et al. 2000). Moreover, there are only a few reports of chromosome counts from Turkish accessions of *Tragopogon* (Wilson 1983; Öztürk et al. 2009), especially concerning the taxa endemic to Turkey. During a taxonomic investigation of *Tragopogon* in Turkey within a project supported by the Scientific and Technological Research Council of Turkey (TUBİTAK), we also focused on chromosome counting of the taxa.

Material and methods

Ripe achenes were collected from natural populations of *Tragopogon* in Turkey and used both for the taxonomic revision of the genus and karyological studies of the taxa. Locality information is provided according to grid square system used in Flora of Turkey (Davis 1965–1985). In this system, the map of Turkey has been divided into 15 equal parts (squares) by three horizontal and five vertical lines based on latitude and longitude. Herbarium material is stored in the herbarium of Karadeniz Technical University, Department of Biology (KTUB) and a few specimens in the herbarium (SOM) of the Institute of Biodiversity and Ecosystem Research, Bulgarian Academy of Sciences. Locality information is provided below. Root tips of germinating achenes were used for chromosome counting. The root tips were pretreated with colchicine solution (0.01%) for 3 h at room temperature, fixed in 3:1 absolute alcohol-glacial acetic acid, hydrolyzed with 1 N HCl for 15 minutes at 60°C, and stained with hematoxylin for 2 h at room temperature (Coşkunçelebi and Vladimirov 2008). Stained root tips were squashed in a drop of 45% acetic acid and permanent slides were prepared with the standard liquid nitrogen method. The best metaphase photographs, enlarged 10x100, were taken using Leica DM 1000 microscope (Wetzlar, Germany) with a digital camera Leica ICC 50 attachment. Chromosomes in mitotic metaphases were counted in at least 10 cells for each taxon.

Results and discussion

The chromosome number of each taxon is given below. The names of the taxa follow Coşkunçelebi and Gültepe (2012). The species are arranged alphabetically.

Tragopogon albinervis Freyn & Sint.

This is a perennial plant and Irano-Turanian (Ir.-Tur.) element growing on rocky slopes and in grassy places. Endemic to Turkey, considered as LC according to IUCN threat category (Ekim et al. 2000).

B7 Erzincan: Kemaliye, 1860 m, 4 July 2011, Coşkunçelebi & M. Gültepe 234.

$2n = 2x = 12$ (Figure 1). This is the first chromosome count for the species collected from the type locality.

Tragopogon buphthalmoides (DC.) Boiss. var. *buphthalmoides*

[Syn.: *T. persicus* Boiss., *T. palaestinus* Boiss., *T. taschkala* Kuth.]

This taxon is perennial and Ir.-Tur. element. It grows in cultivated fields and along roadsides.

A7 Gümüşhane: between Gümüşhane and Şiran, Karamustafa village, 1500 m, 15 July 2006, Coşkunçelebi and Vladimirov 06-46 (KTUB; SOM 169850); B4 Ankara: between Ankara and Konya, 1073 m, 24 May 2010, Coşkunçelebi & M. Gültepe 105 (KTUB) (Figure 2).

$2n = 4x = 24$ (Figure 2). These are the first chromosome counts for the taxon from Turkish accessions. Both populations studied proved to be tetraploid.

Tragopogon buphthalmoides (DC.) Boiss. var. *latifolius* Boiss.

[Syn.: *T. plantagineus* Boiss. & A. Huet.]

The plant is perennial and Ir.-Tur. element. It grows in cultivated fields and along roadsides.

B9 Van: between Erciş-Van, 1680 m, 9 June 2011, Coşkunçelebi & M. Gültepe 209 (KTUB).

$2n = 4x = 24$ (Figure 3). This is the first chromosome count for the taxon from a Turkish accession.

Tragopogon buphthalmoides is represented by two varieties in the Turkish flora (Matthews 1975). Our results for *T. buphthalmoides* var. *buphthalmoides* and *T. buphthalmoides* var. *latifolius* agree with the tetraploid chromosome number of *T. buphthalmoides* reported by Wilson (1983). However, both tetraploid ($2n = 4x = 24$) and hexaploid ($2n = 6x = 36$) cytotypes have been reported for the species earlier (Nazarova 1991; Mavrodiev, Tancig et al. 2008).

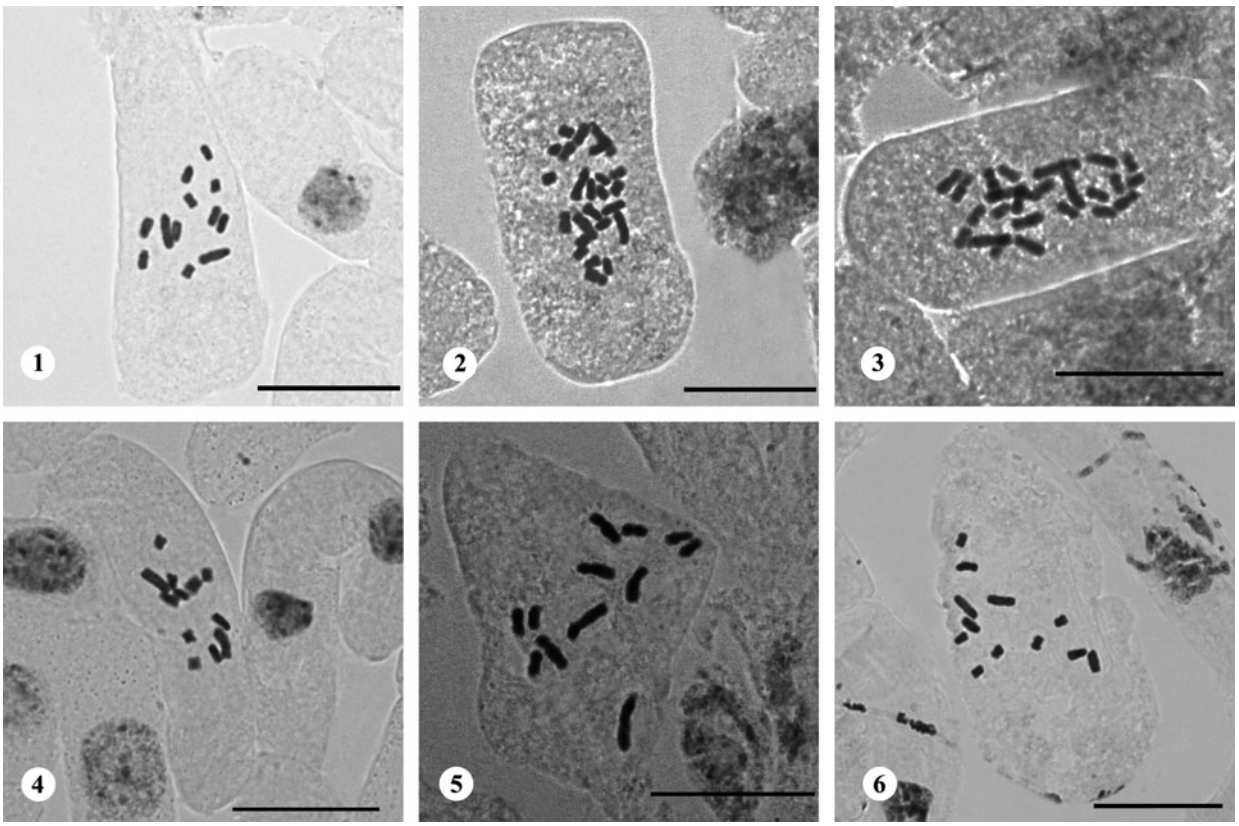
Tragopogon coloratus C.A. Mey.

This biennial plant is an Ir.-Tur. element and grows on stony places and along roadside banks.

A7 Gümüşhane: Zigana mountain, close to Zigana tunnel, 1650 m, 11 July 2006, Coşkunçelebi and Vladimirov 06-35 (KTUB; SOM 169851); A7 Gümüşhane: between Gümüşhane and Şiran, Karamustafa village, 1500 m, 15 July 2006, Coşkunçelebi and Vladimirov 06-45 (KTUB; SOM 169852); B7 Erzincan: Üzümlü, Üzümlü mountain, 1764 m, 9 July 2008, Coşkunçelebi & M. Gültepe 15 (KTUB), (Figure 4).

$2n = 2x = 12$ (Figure 4). The three studied populations are diploid. This chromosome number agrees with a previous report from a Turkish accession (Wilson 1983). However, Nazarova (1991) reported both diploid

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Figures 1–6. Somatic metaphases in *Tragopogon*. (1) *T. albinervis.* (2) *T. buphthalmoides* var. *buphthalmoides*. (3) *T. buphthalmoides* var. *latifolius*. (4) *T. coloratus*. (5) *T. dshimilensis*. (6) *T. dubius.* Scale bars: 20 μm.

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($2n = 2x = 12$) and tetraploid ($2n = 4x = 24$) chromosome numbers for *T. coloratus*.

Tragopogon dshimilensis K. Koch

This taxon is a perennial plant and Euro-Siberian (Euro-Sib.) element growing in grassy places and on roadside banks. It is an endemic species to Turkey.

A7 Gümüşhane: between Gümüşhane and Pazarcık, 1750–1800 m, 17 July 2006, Coşkunçelebi and Vladimirov 06-52 (KTUB; SOM 169853); A8 Rize: İkizdere, Anzer 1982 m, 28 July 2011, Coşkunçelebi & M. Gültepe 302 (KTUB), (Figure 5); A8 Rize: İkizdere, Cimil, 2022 m, 2 August 2012, Coşkunçelebi & M. Gültepe 432 (KTUB).

$2n = 2x = 12$ (Figure 5). This is the first chromosome count for this species. The three studied populations are indicated to be diploid.

Tragopogon dubius Scop.

[Syn.: *T. tauricus* Klokov]

This is a biennial plant and one of the most widespread species growing in fields and on roadside banks.

A1 Çanakkale: between Biga and Lapseki, 131 m, 17 May 2013, Coşkunçelebi & M. Gültepe 439 (KTUB), (Figure 6); B1 Balıkesir: Edremit, Kazdağı, 1725 m, 11 July 2012, Coşkunçelebi & M. Gültepe 383 (KTUB).

$2n = 2x = 12$ (Figure 6). Both populations studied proved to be diploid. These are the first chromosome counts for the species from Turkish accessions and the results are consistent with previous studies from elsewhere (e.g. Ownbey 1950; Wilson 1983).

Tragopogon graminifolius DC.

This is a perennial plant growing in grassy places.

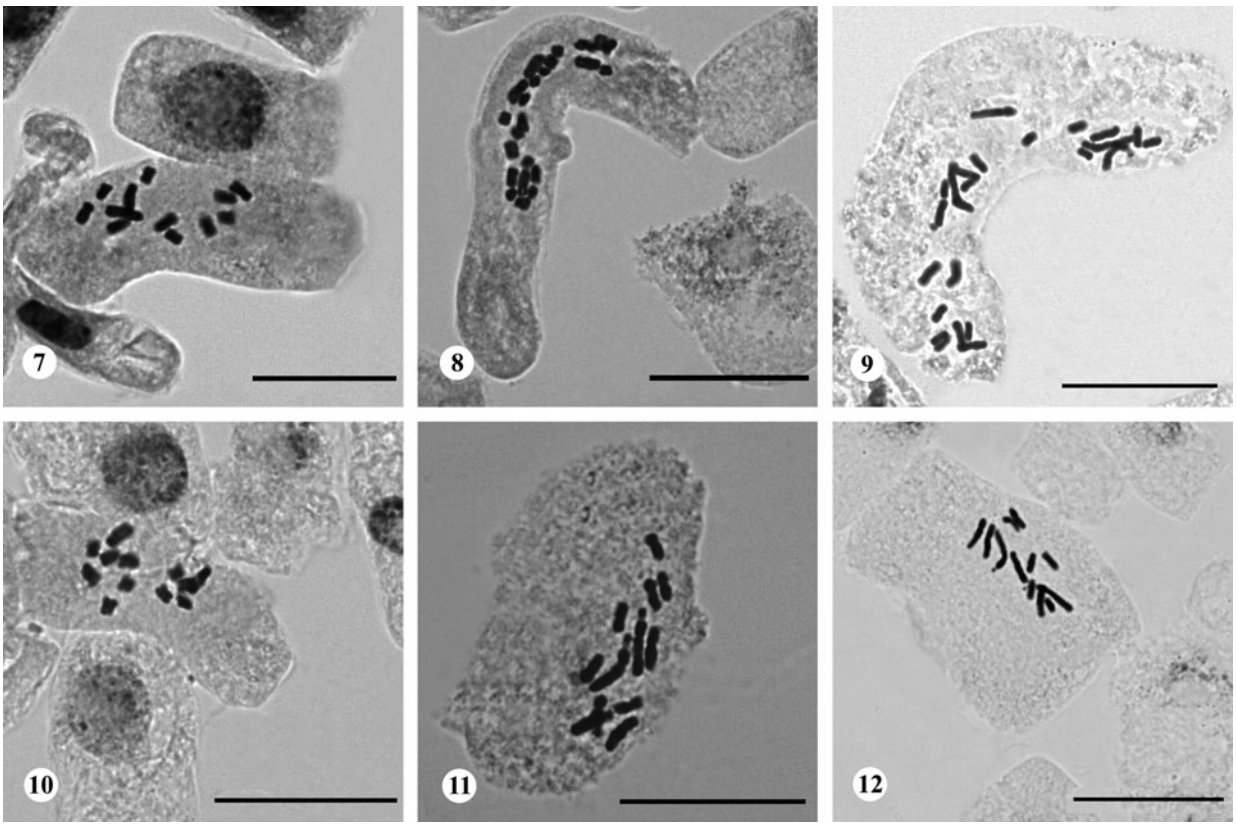
A9 Kars: Kağızman, Zaraphane Village, 1430 m, 15 August 2011, Coşkunçelebi & M. Gültepe 307 (KTUB).

$2n = 2x = 12$ (Figure 7). This is the first chromosome count from a Turkish accession of the species. *Tragopogon graminifolius* was doubtfully recorded from Turkey (Matthews 1975), but its distribution in Turkey was confirmed by Coşkunçelebi and Gültepe (2012). Diploid ($2n = 2x = 12$) and tetraploid ($2n = 4x = 24$) cytotypes were reported for the *T. graminifolius* by Nazarova (1991), but we confirmed only the diploid chromosome number.

Tragopogon latifolius Boiss. var. *angustifolius* Boiss.

This is a biennial plant and Ir.-Tur. element growing in fields and on roadside banks.

C2 Muğla: Seki, Temel Village, 1160 m, 23 May 2012, Coşkunçelebi & M. Gültepe 346 (KTUB).



Figures 7–12. Somatic metaphases in *Tragopogon*. (7) *T. graminifolius*. (8) *T. latifolius* var. *angustifolius*. (9) *T. latifolius* var. *latifolius*. (10) *T. oligolepis*. (11) *T. porrifolius* subsp. *abbreviatus*. (12) *T. porrifolius* subsp. *eriospermus*. Scale bars: 20 μm.

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$2n = 4x = 24$ (Figure 8). This is the first chromosome count for the taxon.

Tragopogon latifolius Boiss. var. *latifolius*

This is a biennial plant and Ir.-Tur. element growing in fields and on roadside banks.

C3 Konya: between Konya and Beyşehir, 1549 m, 12 June 2009, Coşkunçelebi & M. Gültepe 64 (KTUB).

$2n = 4x = 24$ (Figure 9). This count confirms earlier reports for the taxon from Turkey (Wilson 1983).

Tragopogon latifolius is represented by two varieties in the Turkish flora (Matthews 1975), both are determined as tetraploid in the present study. The chromosome number of *T. latifolius* var. *angustifolius* is reported here for the first time from a Turkish accession, whereas the chromosome count for *T. latifolius* var. *latifolius* confirms the earlier counting by Wilson (1983) based on Turkish material. However, both diploid and tetraploid cytotypes of *T. latifolius* have been reported from elsewhere (Nazarova 1991).

Tragopogon oligolepis Hartvig & Strid

This species is endemic to Turkey and considered as EN according to IUCN threat criteria (Ekim et al. 2000). The taxon is a perennial plant and Mediterranean element growing in clearance of *Pinus* forest.

C2 Muğla: Köyceğiz, Sandras Mountain, 1373 m, 23 June 2010, Coşkunçelebi & M. Gültepe 133 (KTUB).

$2n = 2x = 12$ (Figure 10). This is the first chromosome count for this endemic species.

Tragopogon porrifolius L. subsp. *abbreviatus* (Boiss.) Coşkunçelebi & M. Gültepe

[Syn.: *T. longirostris* Sch. Bip. var. *abbreviatus* Boiss.]

This is a biennial plant growing in stony places, fields, and on roadside banks. It is an endemic subspecies to Turkey.

A7 Gümüşhane: Pirahmet, 1909 m, 04 July 2011, Coşkunçelebi & M. Gültepe 230 (KTUB); A7 Gümüşhane: Şiran, Tersun Mountain, 2000–2100 m, 15 July 2006, Coşkunçelebi and Vladimirov 06-47 (KTUB; SOM 169854); C2 Denizli: Honaz Mountain, 1800 m, 13 July 2012, Coşkunçelebi & M. Gültepe 391(KTUB) (Figure 11); C3 Isparta: Davraz Mountain, 1612 m, 14 July 2012, Coşkunçelebi & M. Gültepe 398 (KTUB).

$2n = 2x = 12$ (Figure 11). These are the first chromosome counts for the taxon.

Tragopogon porrifolius L. subsp. *eriospermus* (Ten.) Greuter

[Syn.: *T. eriospermus* Ten., *T. brachyphyllus* (Boiss.) Gand., *T. porrifolius* var. *brachyphyllus* Boiss.]

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The taxon is a biennial plant and Mediterranean element growing in grassy places.

A2 Bursa: Mudanya, 237 m, 2 June 2011, Coşkunçelebi & M. Gültepe 178 (KTUB).

$2n = 2x = 12$ (Figure 12). This is the first count for the taxon from a Turkish accession.

Tragopogon porrifolius L. subsp. *longirostris* (Sch. Bip.) Greuter

[Syn. *T. longirostris* Sch. Bip.]

This is a biennial plant and one of the most widespread species growing in fields and on roadside banks.

C2 Muğla: between Fethiye and Dalaman, Göçek Pass, 327 m, 20 May 2011, Coşkunçelebi & M. Gültepe 164 (KTUB), (Figure 13); A2 Bursa: Mudanya, 237 m, 02 June 2011, Coşkunçelebi & M. Gültepe 179 (KTUB).

$2n = 2x = 12$ (Figure 13). Both populations investigated in the present study are diploid.

T. porrifolius is represented by three subspecies in the Turkish flora: *T. porrifolius* subsp. *abbreviatus*, *T. porrifolius* subsp. *eriospermus*, and *T. porrifolius* subsp. *longirostris* which all proved to be diploids. This is the first chromosome count for the *T. porrifolius* subsp. *abbreviatus*. The chromosome number of *T. porrifolius* subsp. *eriospermus* is reported here for the first time from a Turkish accession, whereas for *T. porrifolius* subsp. *longirostris* the results reported here are congruent with the previous reports of Öztürk et al. (2009) from Turkey.

Tragopogon pratensis L. subsp. *orientalis* (L.) Čelak.

The taxon is an annual or perennial plant and Euro-Sib. element growing in grassy places and on roadsides.

A6 Tokat: between Tokat and Sivas, Kızıliniş Pass, 1113 m, 22 May 2010, Coşkunçelebi & M. Gültepe 99 (KTUB).

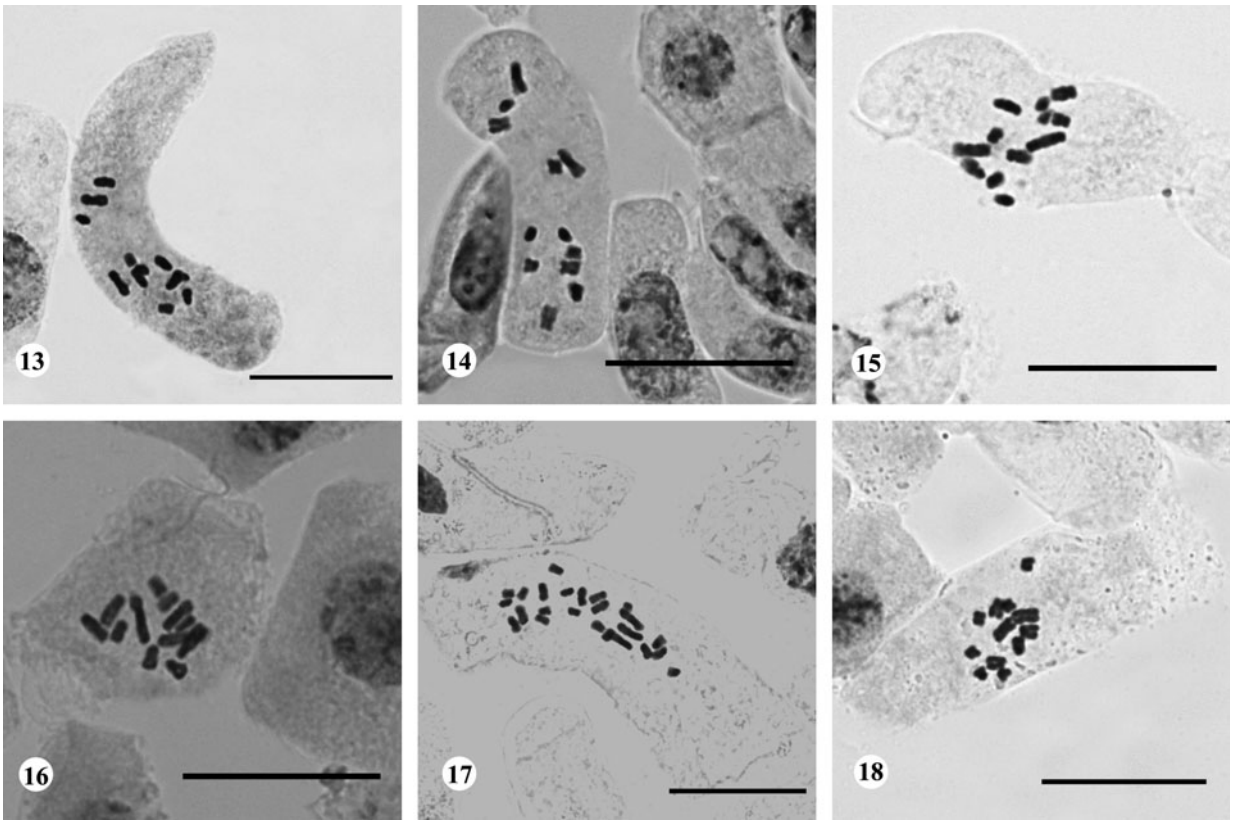
$2n = 2x = 12$ (Figure 14). This is the first count for the taxon from a Turkish accession and the results are consistent with previous studies from elsewhere (e.g. Ownbey 1950; Wilson 1983).

Tragopogon pterocarpus DC.

[Syn.: *T. nachitschevanicus* Kuth.]

This is a biennial plant and Mediterranean element growing on rocky slopes.

B6 Kayseri: between Sarız and Göksun, Işık Mountain, 2252 m, 14 July 2010, Coşkunçelebi & M. Gültepe 150 (KTUB); B6 Kahramanmaraş: Göksun, 1952 m, 22 July 2011, Coşkunçelebi & M. Gültepe 274 (KTUB), (Figure 15).



Figures 13–18. Somatic metaphases in *Tragopogon*. (13) *T. porrifolius* subsp. *longirostris*. (14) *T. pratensis* subsp. *orientalis*. (15) *T. pterocarpus*. (16) *T. pterodes*. (17) *T. reticulatus*. (18) *T. subacaulis*. Scale bars: 20 μm.

$2n = 2x = 12$ (Figure 15). This is the first chromosome count for the taxon from a Turkish accession. Both populations investigated proved to be diploid and the results are consistent with a previous study (Nazarova 1991).

Tragopogon pterodes Pančić

This is a biennial plant growing in fields and stony places.

B6 Sivas: between Sivas and Ulaş, 1345 m, 7 July 2009, Coşkunçelebi & M. Gültepe 52 (KTUB), (Figure 16); A4 Kırıkkale: between Kırıkkale and Elmadağ, Gürlevik Valley, 968 m, 23 June 2011, Coşkunçelebi & M. Gültepe 220.

$2n = 2x = 12$ (Figure 16). These are the first chromosome counts for the species from Turkish accessions. Both populations studied are diploid and the results are consistent with counting of Wilson (1983).

Tragopogon reticulatus Boiss. & A. Huet

This is a perennial plant growing in grassy places and on rocky slopes.

B9 Van: between Başkale and Hoşap, Güzeldere Pass, 2684 m, 20 July 2011, Coşkunçelebi & M. Gültepe 268 (KTUB).

$2n = 4x = 24$ (Figure 17). This is the first report of a tetraploid chromosome number for the species from a Turkish accession.

Nazarova (1991) revealed that *T. reticulatus* included diploid ($2n = 2x = 12$) and several polyploid cytotypes ($2n = 4x = 24$, $2n = 6x = 36$). However, Wilson (1983) reported a diploid chromosome number for *T. reticulatus* counted from Turkish materials (Davis 22767) stored in E!. But according to the authors of the present study, the sample of Davis 22767 (E!) belongs to *T. graminifolius*. We report here for the first time a tetraploid chromosome count ($2n = 4x = 24$) for *T. reticulatus* from a Turkish accession.

Tragopogon subacaulis O. Schwarz

This is a perennial plant and Mediterranean element growing in semi-calcareous places. The taxon is an endemic species to Turkey and is considered as EN according to IUCN threat categories and criteria (Ekim et al. 2000).

B1 Manisa: Spil Mountain, 1239 m, 22 May 2012, Coşkunçelebi & M. Gültepe 169 (KTUB).

$2n = 2x = 12$ (Figure 18). This is the first chromosome count for the species.

Conclusion

This study aimed to provide the chromosome numbers and additional taxonomic data for the systematic treatment of *Tragopogon* in Turkey. This is the first detailed cytological study of the Turkish representatives of *Tragopogon*. It is already known that *Tragopogon* includes diploids, polyploids and polyploid cytotypes (Wilson 1983; Nazarova 1991). However, the chromosome number reported for most species of the genus is diploid, $2n = 12$ (Soltis et al. 2004; Mavrodiev, Soltis et al. 2008). In the present study the chromosome numbers of 18 taxa of *Tragopogon* in Turkey were established as follows: 13 taxa (72%) have diploid somatic chromosome number ($2n = 2x = 12$), whereas the remaining five taxa (28%) are tetraploids ($2n = 4x = 24$). This is in agreement with the suggestion that most species of *Tragopogon* are diploids (Soltis et al. 2004; Mavrodiev, Soltis et al. 2008). However the obtained results in most cases agree with the previous reports (Ownbey and McCollum 1954; Wilson 1983; Nazarova 1991; Öztürk et al. 2009).

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References

Bell CD, Mavrodiev EV, Soltis PS, Calaminus AK, Albach DC, Cellinese N, Garcia-Jacas N, Soltis DE. 2012. Rapid radiation of *Tragopogon* and associated floristic elements in Eurasia. J Evolutionary Biol. 25(12):2470–2480.

Borisova AG. 1964. *Tragopogon*. In: Shishkin BK, editor. Flora of the USSR. vol 29. Moscow: Nauka; p. 115–196.

Bremer K. 1994. Asteraceae. Cladistics and classification. Portland (OR): Timber Press.

Coşkunçelebi K, Gültepe M. 2012. *Tragopogon* L. In: Güner A, editor. A checklist of the flora of Turkey (Vascular Plants). Istanbul: Nezahat Gökyiğit Botanik Bahçesi ve Flora Araştırmaları Derneği Yayını; p. 211–212.

Coşkunçelebi K, Vladimirov V. 2008. IAPT/IOPB chromosome data 5: Chromosome numbers of Turkish *Hieracia & Pilosella* (Asteraceae). Taxon. 57(2):211.

Davis PH, editor. 1965–1985. Flora of Turkey and the east Aegean Islands. Edinburgh; Edinburgh University Press.

Davis PH, Mill RR, Tan K. 1988. Flora of Turkey and the East Aegean Islands. vol 10. Edinburgh: Edinburgh University Press.

Ekim T, Koyuncu M, Vural M, Duman H, Aytaç Z, Adıguzel N. 2000. Red Data Book of Turkish plants. Ankara: Barışcan Ofset.

Favarger C. 1978. Philosophie des comptages de chromosomes. Taxon. 27(5/6):441–448.

Garbari F, Bedini G, Peruzzi L. 2012. Chromosome numbers of the Italian flora. From the Caryologia foundation to present. Caryologia. 65(1):62–71.

Guerra M. 2008. Chromosome numbers in plant cytotaxonomy: Concepts and implications. Cytogenet Genome Res. 120(3/4):339–350.

Güner A, Özhatay N, Ekim T, Başer KHC. 2000. Flora of Turkey and the East Aegean Islands. vol 11. Edinburgh: Edinburgh University Press.

Louzada RB, Silva CP, Corrêa AM, Santos EK, Wanderley MDGL. 2010. Chromosome number of *Orthophytum* species (Bromeliaceae). Kew Bull. 65(1):53–58.

Matthews VA. 1975. *Tragopogon* L. In: Davis PH, editor. Flora of Turkey and the East Aegean Islands. vol 5. Edinburgh: Edinburgh University Press; p. 657–668.

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Mavrodiev EV, Edwards CE, Albach DC, Gitzendanner MA, Soltis PS, Soltis DE. 2004. Phylogenetic relationships in subtribe Scorzonerineae (Asteraceae, Cichorioideae, Cichorioieae) based on ITS sequence data. Taxon. 53(3):699–712.

Mavrodiev EV, Soltis PS, Soltis DE. 2008. Putative parentage of six old world polyploids in *Tragopogon* L. (Asteraceae: Scorzonerinae) based on ITS, ETS, and plastid sequence data. Taxon. 57(4):1215–1232.

Mavrodiev EV, Tancig M, Sherwood AM, Gitzendanner MA, Rocca J, Soltis PS, Soltis DE. 2008. Phylogeny of *Tragopogon* L. (Asteraceae) based on internal and external transcribed spacer sequence data. Int J Plant Sci. 166(1):117–133.

Nazarova EA. 1991. Karyotypical evolution in genus *Tragopogon* L. (Lactuceae, Asteraceae). In: Takhtajan A, editor. Flora, vegetation and vegetable resources of Armenia. Yerevan: Academy of Science of Armenia; p. 116–134.

Ownbey M. 1950. Natural bybridization and amphiploidy in the genus *Tragopogon*. Am J Bot. 37(7):487–499.

Ownbey M, McCollum GB. 1954. The chromosomes of *Tragopogon*. Rhodora. 56(661):7–21.

Öztürk M, Martin E, Dinç M, Duran A, Özdemir A, Çetin Ö. 2009. A cytogenetical study on some plants taxa in Nizip region (Aksaray, Turkey). Turk J Biol. 33(1):35–44.

Poddubnaja-Arnoldi W, Steschina N, Sosnovetz A. 1935. Der charakter und die ursachen der sterilitat bei *Scorzonera* tausaghys Lipsch. et Bosse. Beih Bot Centralblatt. 53A: 309–339.

Rechinger KH. 1977. *Tragopogon* L. In: Rechinger KH, editor. Flora Iranica. vol 122. Graz: Akademische Druck und Verlagsanstalt; p. 83–120.

Richardson IBK. 1976. *Tragopogon* L. In: Tutin TG, Heywood VH, Burges NA, Valentine CH, editors. Flora Europaea. vol 4. Cambridge: Cambridge University Press; p. 322–326.

Soltis DE, Soltis PS, Pires JC, Kovarik A, Tate JA, Mavrodiev E. 2004. Recent and recurrent polyploidy in *Tragopogon* (Asteraceae): Cytogenetic, genomic and genetic comparision. Biol J Linn Soc. 82(4):485–501.

Stace CA. 2000. Cytology and cytogenetics as a fundamental taxonomic resource for the 20th and 21st centuries. Taxon. 49(3):451–477.

Wilson FD. 1983. Karyotypes of *Tragopogon* (Compositae: Lactuceae). Brittonia. 35(4):341–350.

Winge O. 1938. Inheritance of species characters in *Tragopogon.* A cytogenetic investigation. Compt Rend Trav Lab Carlsberg Serie Physiol. 22:155–193.

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