



## Chromosome Counts of Some *Doronicum* (Asteraceae: Senecioneae) Taxa from Turkey

Seher GÜVEN<sup>1\*</sup> Ünsal UMDU TOPSAKAL<sup>2</sup> Osman BEYAZOĞLU<sup>3</sup>

<sup>1</sup>Recep Tayyip Erdogan University, Faculty of Sciences and Arts, Department of Biology, 53100, Rize, Turkey

<sup>2</sup>Yıldız Technical University, Faculty of Education, Department of Mathematics and Science Education, 34210 Istanbul, Turkey

<sup>3</sup>Karadeniz Technical University, Faculty of Sciences, Department of Biology, 61080 Trabzon, Turkey

Geliş/Received: 25.08.2020

Kabul/Accepted: 21.11.2020

How to cite: Güven, S., Umdu Topsakal, Ü. & Beyazoğlu, O. (2020). Chromosome Counts of Some *Doronicum* (Asteraceae: Senecioneae) Taxa from Turkey. *J. Anatolian Env. and Anim. Sciences*, 5(4), 605-610.

Atıf yapmak için: Güven, S., Umdu Topsakal, Ü. & Beyazoğlu, O. (2020). Türkiye'den Bazı *Doronicum* (Asteraceae: Senecioneae) Taksonlarının Kromozom Sayıları. *Anadolu Çev. ve Hay. Dergisi*, 5(4), 605-610.

\*ID: <https://orcid.org/0000-0001-8883-8489>  
ID: <https://orcid.org/0000-0002-0565-7891>  
ID: <https://orcid.org/0000-0001-9744-8642>

### \*Corresponding author's:

Seher GÜVEN

Recep Tayyip Erdoğan University, Faculty of Sciences and Arts, Department of Biology, 53100, Rize, Turkey.

✉: [seher.cakmak@erdogan.edu.tr](mailto:seher.cakmak@erdogan.edu.tr)

Mobile telephone : +90 (536) 578 74 90

**Abstract:** In the present study, mitotic chromosome numbers of seven taxa of *Doronicum* (Asteraceae) from the northeast Anatolia, two of which are endemic to Turkey, were counted. The chromosome counts of *D. haussknechtii*, *D. dolichotrichum*, *D. maximum* and *D. reticulatum* were reported in this research for the first time. Somatic chromosome numbers were counted using squash preparations obtained from active root tips. All the investigated taxa have been proven to be diploid ( $2n=60$ ). This research, consistent with the previously reported chromosome counts of the members of *Doronicum*, has contributed to chromosome number data of the genus.

**Keywords:** Chromosome count, *Doronicum*, Senecioneae, Anatolia.

## Türkiye'den Bazı *Doronicum* (Asteraceae: Senecioneae) Taksonlarının Kromozom Sayıları

### \*Sorumlu yazar:

Seher GÜVEN

Recep Tayyip Erdoğan Üniversitesi, Fen Edebiyat Fakültesi, Biyoloji Bölümü, 53100, Rize, Türkiye.

✉: [seher.cakmak@erdogan.edu.tr](mailto:seher.cakmak@erdogan.edu.tr)

Mobile telephone : +90 (536) 578 74 90

**Öz:** Bu çalışmada, Kuzeydoğu Anadolu'dan iki tanesi Türkiye endemiği olan yedi *Doronicum* (Asteraceae) taksonunun mitotik kromozom sayıları sayılmıştır. *D. haussknechtii*, *D. dolichotrichum*, *D. maximum* ve *D. reticulatum*'ün kromozom sayıları ilk kez bu çalışmada bildirilmiştir. Somatik kromozom sayımları, aktif kök uçlarından elde edilen ezme preparatları kullanılarak sayıldı. İncelenen tüm taksonların diploid ( $2n=60$ ) olduğu kanıtlanmıştır. *Doronicum* üyelerinin daha önce bildirilen kromozom sayıları ile uygunluk gösteren bu araştırma, cinsin kromozom sayısı verilerine katkı sağlamıştır.

**Anahtar kelimeler:** Kromozom sayısı, *Doronicum*, Senecioneae, Anadolu.

## INTRODUCTION

*Doronicum* L. (Asteraceae: Senecioneae) comprises 26 species and 4 subspecies naturally growing in open or forest habitats from sea level up to 5000 m height in a geographic region extending from Europe and North Africa to Asia (Álvarez Fernández, 2003). The members of the genus are characterized by perennial rhizomatous herbs with alternate simple leaves, one to several radiate yellow-flowered capitula comprising an

involucral of herbaceous phyllaries arranged in 2 or 3 rows, and cylindrical to obovate-cylindrical shaped cypselae with 10 longitudinal ribs (Álvarez Fernández et al., 2001). The first world-wide monograph of the genus *Doronicum* was carried out by Cavillier (1907, 1911). In recent years, more comprehensive taxonomic revisions of *Doronicum* which contributed to the systematics of the genus, have been performed on the basis of morphological and

molecular data (Álvarez Fernández & Nieto Feliner, 1999; Álvarez Fernández et al., 2001; Álvarez Fernández, 2003). Up to now, also many karyological (Lindqvist, 1950; Skalinska, 1950; Baksay, 1956; Contandriopoulos, 1957; Favarger & Küpfer, 1968; Lovka et al., 1972; Kuzmanov & Ancev 1973; Löve & Kjellqvist, 1974; Garbari et al., 1980; Van Loon, 1980; Belaeva & Siplivinsky, 1981; Van Loon & Oudemans, 1982; Kuzmanov & Georgieva, 1983; Strid & Franzén, 1983; Davlianidze, 1985; Strid & Anderson, 1985; Chacón, 1987; Lippert & Heubl, 1988; Tassenkevitch et al., 1989; Vir Jee & Kachroo, 1989; Baltisberger, 1991; Ruiz de Clavijo, 1993; Pachschwöll et al., 2015) and chemical (Paolini et al., 2007; Lazarević et al., 2009; Bharti et al., 2012; Syed et al., 2014) studies including several *Doronicum* taxa have been reported on the genus.

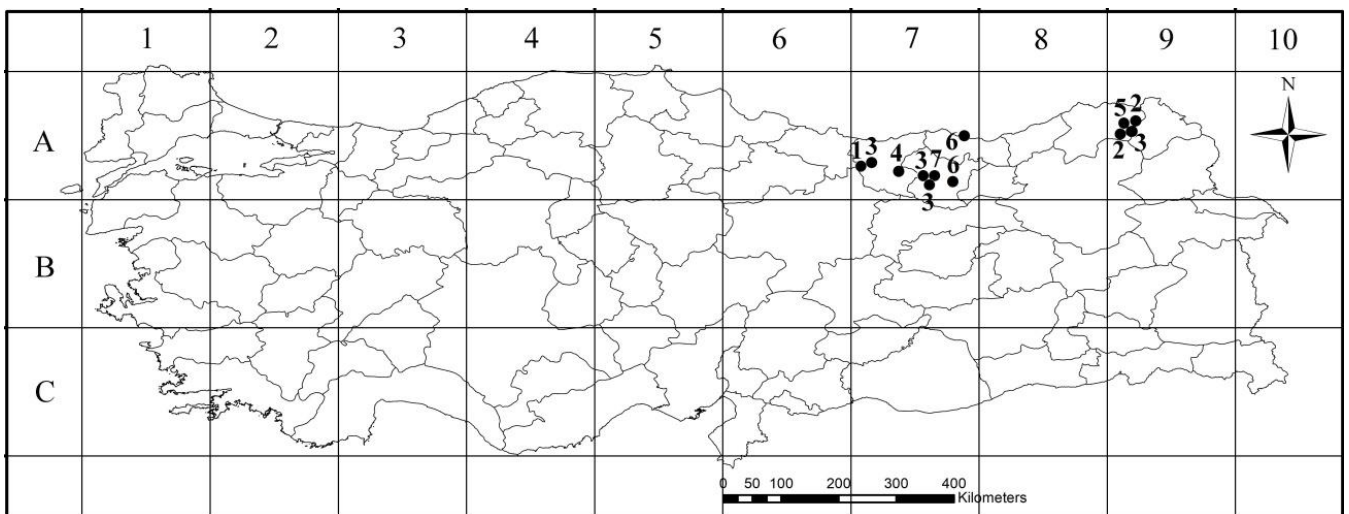
The first taxonomic revision of Turkish *Doronicum* was performed by Edmondson (1975), who recognized 13 species and two subspecies. Since then, Álvarez Fernández (2003) has prepared the latest worldwide revision of *Doronicum* including several nomenclature and taxonomic clarifications, and listed 30 taxa, 10 of which also distributed in Turkey with approximately 30% endemism rate (*D. cacaliifolium* Boiss. & Heldr., *D. haussknechtii* Cavill. and *D. reticulatum* Boiss.). In the present paper, we preferred to use the plant names accepted in the taxonomic treatment of Álvarez Fernández (2003) for the studied taxa. *Doronicum* grows in various habitats as damp meadows, streamside, shady or rocky places in *Juniperus* L. scrub, *Abies* Mill. dominated woodland, and alpine and subalpine forest margins at the altitude of 50-2900 m in Turkey (Edmondson, 1975). The species of subsection *Macrophylla* Cavill. forming the majority of *Doronicum* species in Turkey, was considered to be a systematically difficult taxonomic group in which indumentum characters

have great importance for distinguishing the taxa (Edmondson, 1975). There have been reported some chemical (Akpınar et al., 2009), ethnobotanical (Uğurlu & Secmen, 2007; Arı et al., 2015) and molecular (Kadıoğlu, 2013) studies including only a few Turkish *Doronicum* taxa.

Chromosome number data are valuable today in systematics. Although the documentation of chromosome number is a priority for the conservation of the world's plant genetic resources, to date, chromosome number data of only approximately 25 % of flowering plants have been determined (Stace, 2000; Garbari et al., 2012). Despite the great floristic richness of Turkey, only 15 % of the vascular plant taxa have had their chromosome number investigated (Vladimirov et al., 2015). Very few counts have been reported in the literature previously for the genus *Doronicum*. The present study aims to report the chromosome number of seven Turkish representatives of *Doronicum*, two of which are endemic to Turkey. Our study will contribute to the knowledge of the chromosome number of the genus.

## MATERIAL AND METHOD

**Sampling:** Locality information of 12 representatives of seven Turkish *Doronicum* taxa used for chromosome counting is given in Table 1, and the distribution of the examined taxa are shown in Figure 1 using Turkey Grid System (Davis, 1965). All specimens were first processed using the standard herbarium techniques given by Woodland (1997). They were identified using the Flora of Turkey and The east Aegean Islands (Edmondson, 1975), and stored at the Herbarium of Karadeniz Technical University, Department of Biology (KTUB).



**Figure 1.** Distribution map of the examined taxa according to grid square system of Davis (1965) (Refer to Table 1 for explanation of accession no).

**Table 1.** Locality information of the examined specimens.

No	Taxa	Locality	Date	Voucher number
1	<i>Doronicum haussknechtii</i> Cavill	A7Giresun: Karagöl, 2620 m	02 viii 2002	Umdu 23
2	<i>Doronicum dolichotrichum</i> Cavill.	A9Artvin: Ardanuç, Kutul Plateau, 2200 m	02 iii 2003	Umdu 47
		A9Artvin: Şavşat, Büyük Sahara, 2450 m	04 vii 2003	Umdu 71
		A7Gümüşhane: Artabel Lakes Nature Park, 2200-2500 m	24 vii 2003	Umdu 91
3	<i>Doronicum macrophyllum</i> Fisch. subsp. <i>macrophyllum</i>	A7Giresun: Aksu Village, 1800 m	02 viii 2002	Umdu 26
		A9Ardahan: Bağdaşen Village, 2300 m	06 viii 2003	Umdu 83
		A7Gümüşhane: Artabel Lakes Nature Park, 2000-2900 m	24 viii 2004	Umdu 97
4	<i>Doronicum maximum</i> Boiss. & A.Huet	A7Giresun: Balaban Mountain, 2700 m	02 viii 2002	Umdu 24
5	<i>Doronicum oblongifolium</i> DC.	A9Artvin: Ardanuç, Kürdevan Mountain, 2700 m	03 vii 2004	Umdu 113
6	<i>Doronicum orientale</i> Hoffm	A7Gümüşhane: Köse Mountain, 1900m	05 vi 2002	Umdu 21
		A7Trabzon: K.T.Ü. Campus, 50 m	30 iii 2002	Umdu 11
7	<i>Doronicum reticulatum</i> Boiss.	A7Gümüşhane: Artabel Lakes Nature Park, 2800 m	27 vii 2002	Umdu 31

**Cytological analyses:** Actively growing root tips were used for somatic chromosome counts. At first, the roots of the living plants were cleaned of soil particles, and then 1–1.5 cm long root tips were cut off and pre-treated with 0.5 % colchicine for 3 hours in the field. Then the samples were treated to the fixation process using the Carnoy solution (3:1 absolute alcohol: glacial acetic acid) for at least 24 hours at +4°C. Fixed root tips were transferred to 70 % alcohol and stored at +4 °C until analyses. Afterwards, the root tips were hydrolyzed with 1 N HCl for 12 minutes at 60°C and stained with 2 % aceto-orcein for 24 hours at room temperature. Stained root tips were squashed in a drop of 45 % acetic acid, and the preparations were mounted in entellan to obtain permanent slides (Jones & Rickards, 1991; Elçi, 1994; Martin et al., 2012). The best metaphase plates, including at least ten well-spread cells, were photographed with Olympus BX51 microscope with a digital camera attachment. Also, the chromosomes were drawn from the permanent slides and counted individually by using both enlarged photographs (10 × 100) and drawings.

## RESULTS

Chromosome counts of 12 accessions belonging to seven taxa of *Doronicum* from Turkey were presented in Figures 2-3. The somatic chromosome numbers were determined as  $2n=2x=60$  for all the examined taxa. To the best of our knowledge, these are the first chromosome counts for *D. haussknechtii*, *D. dolichotrichum*, *D. maximum* and *D. reticulatum*.

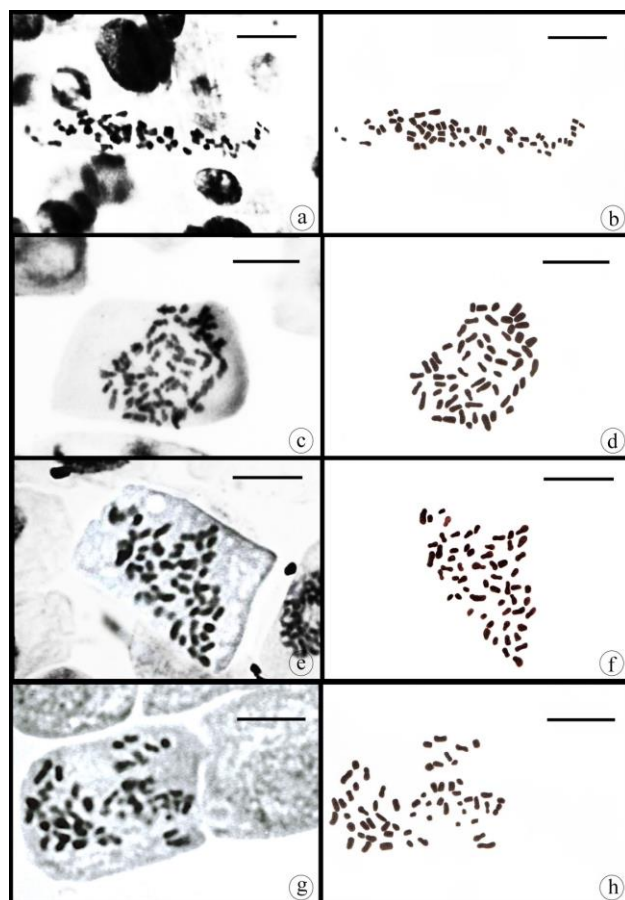
***Doronicum haussknechtii* Cavill.** Syn: *Doronicum tobeyi* J.R.Edmondson:

This species is one of the Turkish endemics growing in streams at an altitude of 2600 m in B6 and A7 squares (Edmondson, 1975; Umdu, 2005). IUCN threat category of *D. haussknechtii* was considered as Near Threatened (NT) by Ekim et al., (2000). It proved to be  $2n=2x=60$  (Figure 2a-b) from one Turkish population.

***Doronicum dolichotrichum* Cavill.** Syn: *D. hakkiaricum* Edmondson, *D. hyrcanum* Widd. & Rech. fil.:

This species is a Euxine element which was described from Caucasia. It is distributed in mountain flushes, lush alpine meadows and streamside at the altitude

of 2000-2900 m in A7, A9 and C9 squares (Edmondson, 1975; Umdu, 2005). It proved to be  $2n=2x=60$  (Figure 2c-d) from two Turkish accessions.



**Figure 2.** Somatic metaphases: a-b. *D. haussknechtii* (Umdu 23,  $2n=60$ ), c-d. *D. dolichotrichum* (Umdu 47,  $2n=60$ ), e-f. *D. macrophyllum* subsp. *macrophyllum* (Umdu 97,  $2n=60$ ), g-h. *D. maximum* (Umdu 24,  $2n=60$ ) (a, c, e, photo, b, d, f, drawing, bar: 10 µm).

***Doronicum macrophyllum* Fisch. subsp. *macrophyllum*.** Syn: *D. balansae* Cavill., *D. macrolepis* Freyn & Sint.:

This taxa, one of the Euxine elements of *Doronicum* described from Caucasia, is distributed at the altitude of 1480-2900 m in alpine and subalpine forest margins and meadows in the northeast of Anatolia (A7, A8, and A9 squares) (Edmondson, 1975; Umdu, 2005). It possessed  $2n=2x=60$  (Figure 2e-f) in four Turkish accessions.

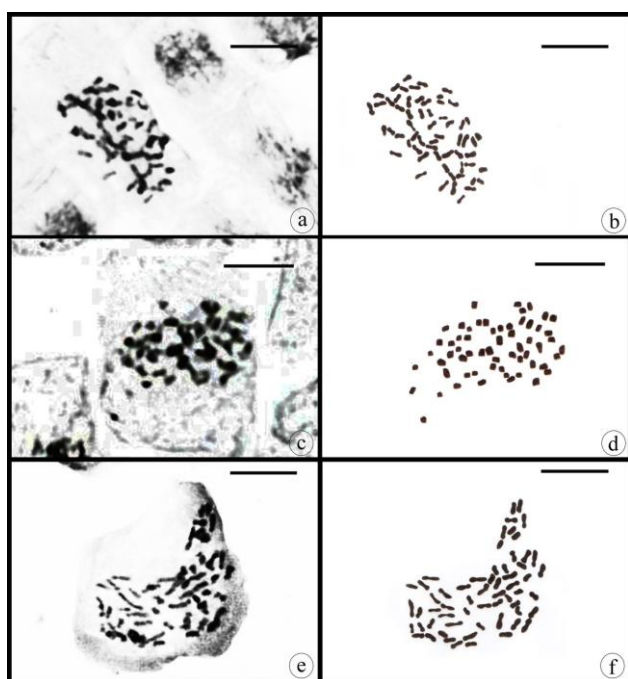


***Doronicum maximum* Boiss. & A.Huet:**

This taxon is the most widespread species of subsect. *Macrophylla* Cavill in Turkey growing on the streamside and moist rocky places at the altitude of 2100-2900 m (Edmondson, 1975; Umdu, 2005). The somatic chromosome number was determined as  $2n=2x=60$  (Figure 2g-h) from one Turkish accession.

***Doronicum oblongifolium* DC.:**

This species, one of the Caucasia originated *Doronicum* members, grows in open moist rocky places along with watercourses at the altitude of 2000-2700 m in the northeast of Anatolia (A9 square) (Edmondson, 1975; Umdu, 2005). The present study provided the diploid chromosome number of  $2n=2x=60$  for *D. oblongifolium* (Figure 3a-b) from one Turkish accession.



**Figure 3.** Somatic metaphases: a-b. *D. oblongifolium* (Umdu 113,  $2n=60$ ), c-d. *D. orientale* (Umdu 21,  $2n=60$ ), e-f. *D. reticulatum* (Umdu 31,  $2n=60$ ) (a,c,e. photo, b,d,f. drawing, bar: 10  $\mu$ m).

***Doronicum orientale* Hoffm.:**

*D. orientale* is the most widespread species of the genus in Turkey which is largely restricted to the western half of the country in shady places in the forest and scrub at the altitude of 50-2000 m (Edmondson, 1975; Umdu, 2005). The somatic chromosome number of this species was determined as  $2n=2x=60$  (Figure 3c-d) from two Turkish accessions.

***Doronicum reticulatum* Boiss.** Syn: *D. bithynicum* Edmondson, *D. bithynicum* subsp. *bithynicum*, *D. thirkei* Sch. Bip. ex Boiss.

This species, endemic to Turkey, is a E. Medit. element growing on rocky slopes and *Juniperus* scrub at the altitude of 1450-2800 m in A2(A), A3, A7, B2 and B3 squares (Edmondson, 1975; Umdu, 2005). IUCN threat

category of *D. reticulatum* was considered as Vulnerable (VU) by Ekim et al., (2000). The somatic chromosome number was counted as  $2n=2x=60$  (Figure 3e-f) from one Turkish accession.

**DISCUSSION**

Bremer (1994) reported that the basic chromosome number of the genus *Doronicum* is  $x=30$ , which is characteristic for the "cacalioid" group in Senecioneae. However, previous authors suggested  $x=10$  for the genus (Fernandes & Queirós, 1971; Májovský & Murin, 1987). The most recent chromosome counts related to many *Doronicum* taxa providing multiples of 30 ( $2n=60$ ) supported the basic number of  $x=30$  for the genus and indicated that polyploidy is common within the genus (Álvarez Fernández, 2003). The chromosome number was reported as  $2n=60$  for *D. glaciale* (Wulfen) Nym. and *D. grandiflorum* Lam. (Pachschwöll et al., 2015),  $2n=120$  for *D. plantagineum* L., (Löve & Kjellqvist, 1974; Ruiz de Clavijo, 1993) and *D. stiriicum* (Vill.) Dalla Torre (Murin, 1978; Pachschwöll et al., 2015) while some taxa showed both ploidy levels (e.g., *D. carpetanum* Boiss. & Reuter ex Willk. & Lange  $2n=60, 120$  (Chacón, 1987), *D. clusii* (All.) Tausch  $2n=60, 120$  (Tasenkevitch et al., 1989; Huber & Baltisberger, 1992; Pachschwöll et al. 2015), *D. altaicum* Pall.  $2n=30, 60$  (Zhukova, 1967; Stepanov, 1994), *D. macrophyllum*  $2n=30, 60$  (Zhukova, 1967; Davlianidze, 1984), *D. oblongifolium*  $2n=40, 60$  (Zhukova, 1967; Davlianidze, 1985). In the present study, the somatic chromosome number of  $2n=2x=60$  was counted for the investigated seven taxa of *Doronicum* (Asteraceae) from Turkey. Our results are in agreement with the previous counts in the literature. To our knowledge, these results are new to science for *D. dolichotrichum*, a Euxine element (Figure 2c-d), *D. maximum*, the most widespread *Doronicum* in Turkey (Figure 2g-h), and the two Turkish endemic taxa, *D. haussknechtii* (Figure 2a-b) and *D. reticulatum* (Figure 3e-f). Most of the species investigated in this paper are distributed at alpine regions. Polyploidisation and hybridization are considered among the major factors affecting high-mountain biodiversity for Asteraceae and also in *Doronicum* (Pachschwöll et al., 2015; Álvarez Fernández, 2003). Polyploid species are thought to be common in alpine environments due to their potential for increased adaptability to extreme conditions (Pachschwöll et al., 2015). However, the phenomenon stating the significant effect of polyploidization on patterns and diversification rates is still controversial (Otto & Whitton, 2000). Besides, Mas de Xaxars et al. (2016) hypothesized that compared to polyploidy, dysploidy could be more affective in evolutionary processes in high mountain *Artemisia*.

*D. macrophyllum* subsp. *macrophyllum* possesses  $2n=2x=60$  (Figure 2e-f). This is the first chromosome count for the taxon from a Turkish accession. Our result is consistent with the previous count reported by Zhukova (1967) in Russia. However,  $2n=30$  diploid chromosome number has been reported from Georgia for *D. macrophyllum* (Davlianidze, 1984). The geographical

distribution of the taxa has been considered among the main reasons for the ploidy level variation within the plant species (Morawetz, 1984). Özcan et al. (2008) also reported that plant taxa originating from different geographical regions can have different chromosome numbers.

The present study provided the diploid chromosome number of  $2n=2x=60$  for *D. oblongifolium* (Figure 3a-b) from a Turkish accession for the first time. Our result is in agreement with the counts by Sietozaroia (1967) and Zhukova (1967) from Russia. However,  $2n=2x=40$  diploid chromosome number has been reported from Georgia for *D. oblongifolium* (Davlianidze, 1985). This is the only count that is inconsistent with  $x=30$ , and according to Álvarez Fernández (2003), it should be recounted. Our counting of  $2n=2x=60$  for *D. orientale* (Figure 3c-d) is consistent with several previous counts reported for this species by Sietozaroia (1967) in Russia, Larsen & Laegaard (1971) in Sicilia, Strid & Anderson (1985) in Greek, Peruzzi et al., (2012) in Italy.

The chromosome numbers of seven *Doronicum* taxa are reported for the first time from Turkish accessions. Although no difference was determined among the examined species in terms of somatic chromosome number, the present paper has made an important contribution to the knowledge of the chromosome number of the genus *Doronicum*.

## REFERENCES

- Akpinar, K., Yildirim, N., Üçüncü, O., Yayli, N. & Terzioğlu, S. (2009). The volatile constituents of the flowers and leaves-stems of three *Doronicum* taxa from Turkey. *Asian Journal of Chemistry*, **21**, 1225-1229.
- Arı, S., Temel, M., Kargioğlu, M. & Konuk, M. (2015). Ethnobotanical survey of plants used in Afyonkarahisar-Turkey. *Journal of Ethnobiology and Ethnomedicine*, **11**, 84. DOI: 10.1186/s13002-015-0067-6.
- Álvarez Fernández, I., Fuertes Aguilar, J., Panero, J.L. & Nieto Feliner, G. (2001). A phylogenetic analysis of *Doronicum* (Asteraceae, Senecioneae) based on morphological, nuclear ribosomal (ITS), and chloroplast (trnL-F) evidence. *Molecular Phylogenetics and Evolution*, **20**, 41-64. DOI: 10.1006/mpev.2001.0954.
- Álvarez Fernández, I. (2003). Systematics of the Eurasian and North-African genus *Doronicum* (Asteraceae, Senecioneae). *Annals of the Missouri Botanical Garden*, **90**, 319-389. DOI: 10.2307/3298534.
- Álvarez Fernández, I. & Nieto Feliner, G. (1999). Lectotypification of 16 species names in *Doronicum* (Asteraceae, Senecioneae). *Taxon*, **48**, 801-806. DOI: 10.2307/1223652.
- Bharti, R., Ahuja, G., Ganapathy, S. & Dakappa, S.S. (2012). A review on medicinal plants having Antioxidant potential. *Journal of Pharmacy Research*, **5**(8), 4278-4287.
- Baksay, L. (1956). Cytotaxonomical studies on the Flora of Hungary. *Annales Historico-Naturales Musei Nationalis Hungarici*, **7**, 321-334.
- Baltisberger, M. (1991). *Cytological investigations of some Greek plants*, Fl. Medit. 1, 164p.
- Belaeva, V.A. & Siplivinsky, V. (1981). IOPB chromosome number reports. *Taxon*, **30**, 860.
- Bremer, K. (1994). *Asteraceae: Cladistics and Classification*, Timber Press, Portland, Oregon.
- Cavillier, F. (1907). Étude sur les *Doronicum* à fruits homomorphes. *Annuaire du Conservatoire et du Jardin Botaniques de Genève*, **10**, 177-251.
- Cavillier, F. (1911). Nouvelles études sur le genre *Doronicum*. *Annuaire du Conservatoire et du Jardin Botaniques de Genève*, **13-14**, 195-368.
- Chacón, A.R. (1987). Contribución al estudio taxonómico del género *Doronicum* L. (Compositae) en la Península Ibérica. *Anales del Jardín Botánico de Madrid*, **43**, 253-270.
- Contandriopoulos, J. (1957). Contribution à l'étude caryologique des endémiques de la Corse. *Annales de la Faculté des sciences de Marseille*, **26**, 51-65.
- Davis, P.H., (1965). *Flora of Turkey and the East Aegean Islands, vol. 1*, Edinburgh University Press.
- Davlianidze, M.T. (1985). Chromosome numbers in the representatives of the flora from Georgia. *Botanicheskii Zhurnal*, **70**(5), 698-700.
- Davlianidze, M.T. (1984). Investigatio cytogeographics speciorum nonnullarum altimontanarum e Caucaso. *Notas Systematic Georgia Institute Botany Tbilissi*, **40**, 56-66.
- Edmondson, J.R. (1975). *Doronicum* L. In: Davis, P.H. (Ed), *Flora of Turkey and the East Aegean Islands. Vol. 5*, 137-145 pp, Univ. Edinburgh Press, Edinburgh.
- Ekim, T., Koyuncu, M., Vural, M., Duman, H., Aytaç, Z. & Adıgüzel, N. (2000). *Türkiye Bitkileri Kırmızı Kitabı*, Van YY. Üniversitesi & Doğa Derneği, Ankara, Barışcan Ofset.
- Elçi, Ş. (1994). *Sitogenetikte araştırma yöntemleri ve gözlemler*, 100. Yıl Üniversitesi Yayınları, Van (Turkey).
- Favarger, C. & Küpfer, P. (1968). Contribution à la cytotaxonomie de la flore alpine des Pyrénées. *Collectanea Botanica (Barcelona)*, **6**, 325-352.
- Fernandes, A. & Queirós, M. (1971). Contribution à la connaissance cytotaxonomique des Spermatophyta du Portugal. *Boletim da Sociedade Broteriana*, **45**, 5-21.
- Garbari, F., Miceli, P. & Monti, G. (1980). Numeri cromosomici per la Flora Italiana. *Informatore Botanico Italiano*, **12**, 110.
- Garbari, F., Bedini, G. & Peruzzi, L. (2012). Chromosome numbers of the Italian flora. From the Caryologia foundation to present. *Caryologia*, **65**(1), 62-71. DOI: 10.1080/00087114.2012.678090.
- Huber, W. & Baltisberger, M. (1992). IOPB chromosome data 4. *International Organization of Plant Biosystematists Newsletter (Zurich)*, **18/19**, 6-8.
- Jones, R.N. & Rickards, G.K. (1991). *Practical genetics*, Open University Press, Philadelphia.
- Kadioğlu, E. (2013). *Doronicum orientale Hoffm. Türünün Popülasyon Düzeyinde Bazı Moleküler Özellikler Açısından Değerlendirilmesi*, Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü. Trabzon, Türkiye, 46p.
- Kuzmanov, B.A. & Ancev, M.E. (1973). IOPB chromosome number reports. *Taxon*, **22**, 461.

- Kuzmanov, B.A. & Georgieva, S. (1983).** IOPB chromosome number reports. *Taxon*, **32**, 665.
- Larsen, K. & Laegaard, S. (1971).** Chromosome studies of the sicilian flora. *Botanisk Tidsskrift*, **66**(3), 249-268.
- Lazarević, J., Radulović, N., Palić, R. & Zlatkovic, B. (2009).** Chemical composition of the essential oil of *Doronicum austriacum* Jacq. subsp. *giganteum* (Griseb.) Stoj. et Stef (Compositae) From Serbia. *Journal of Essential Oil Research*, **21**, 507-10. DOI: [10.1080/10412905.2009.9700230](https://doi.org/10.1080/10412905.2009.9700230).
- Lindqvist, K. (1950).** Some results of a cytological investigation of *Doronicum*. *Hereditas*, **36**, 94-102.
- Lippert, W. & Heubl, G.R. (1988).** Chromosomenzahlen von Pflanzen aus Bayern und angrenzenden Gebieten. *Berichte der Bayerischen Botanischen*, **59**, 13-22.
- Lovka, M., Susnik, F., Löve, A. & Löve, D. (1972).** IOPB chromosome number reports. *Taxon*, **21**, 337-339.
- Löve, A. & Kjellqvist, E. (1974).** Cytotaxonomy of Spanish plants. IV. Dicotyledons: Caesalpiniaceae-Asteraceae. *Lagascalia*, **4**, 153-211.
- Májovský, J. & Murin, A. (1987).** *Karyotaxonomicky Prehl'ad Flory slovenska*, Veda Vydavateľ'stvo Slovenskej Akademie Vied, Bratislava.
- Martin, E., Çetin, Ö., Makbul, S., Duran, A., Öztürk, M., Boduroğlu, D. & Eşmekaya, B. (2012).** Karyology of the *Scorzonera* L. (Asteraceae) taxa from Turkey. *Turkish Journal Of Biology*, **36**, 187-199.
- Mas de Xaxars, G., Garnatje, T., Pellicer, J., Siljak-Yakovlev, S., Valles, J. & Garcia, S. (2016).** Impact of dysploidy and polyploidy on the diversification of high mountain *Artemisia* (Asteraceae) and allies. *Alpine Botany*, **126**, 35-48. DOI: [10.1007/s00035-015-0159-x](https://doi.org/10.1007/s00035-015-0159-x).
- Morawetz, W. (1984).** Karyological races and ecology of the Brazilian *Duguetia furfuracea* as compared with *Xylopia aromatica* (Annonaceae). *Flora*, **175**, 195-209.
- Murin, A. (1978).** In: Index of chromosome numbers of Slovakian flora. Part 6. *Acta Facultatis Rerum Naturalium Universitatis Comenianae, Botanica*. **26**, 1-42.
- Ozcan, M., Ayaz, S.H. & İnceer, H. (2008).** Chromosome counts of some *Cirsium* (Asteraceae, Cardueae) taxa from Turkey. *Caryologia*, **61**(4), 375-382. DOI: [10.1080/00087114.2008.10589649](https://doi.org/10.1080/00087114.2008.10589649).
- Pachschwöll, C., Escobar García, P., Winkler, M., Schneeweiss, G.M. & Schönswetter, P. (2015).** Polyploidisation and geographic differentiation drive diversification in a European high mountain plant group (*Doronicum clusii* Aggregate, Asteraceae). *PLOS ONE*, **10**(3). DOI: [10.1371/journal.pone.0118197](https://doi.org/10.1371/journal.pone.0118197)
- Paolini, J., Muselli, A., Bernardini, A.F., Bighelli, A., Casanova, J. & Costa, J. (2007).** Thymol derivatives from essential oil of *Doronicum corsicum* L. *Flavour and Fragrance Journal*, **22**, 479-487. DOI: [10.1002/ffj.1824](https://doi.org/10.1002/ffj.1824).
- Peruzzi, L., Bedini, G. & Andreucci, A. (2012).** Homoploid hybrid speciation in *Doronicum* (Asteraceae)? Morphological, karyological and molecular evidences. *Plant Biosystems*, **146**(4), 867-877. DOI: [10.1080/11263504.2011.634445](https://doi.org/10.1080/11263504.2011.634445).
- Ruiz de Clavijo, E. (1993).** Números cromosómicos para la flora Española 664-690. *Lagascalia*, **17**, 161-172.
- Otto, S.P. & Whitton, J. (2000).** Polyploid Incidence And Evolution. *Annual Review of Genetics*, **34**(1), 401-437. DOI: [10.1146/annurev.genet.34.1.401](https://doi.org/10.1146/annurev.genet.34.1.401)
- Sietozaroia, V.V. (1967).** Sporogenez nektorix vidov *Doronicum* L. *Biull. Glav. Bot. Sad.*, **67**, 36-42.
- Skalinska, M. (1950).** Studies in chromosome numbers of Polish angiosperms. *Acta Societatis Botanicorum Poloniae*, **20**, 45-68.
- Stace, C.A. (2000).** Cytology and cytogenetics as a fundamental taxonomic resource for the 20<sup>th</sup> and 21<sup>st</sup> centuries. *Taxon*, **49**(3), 451-477.
- Stepanov, N.V. (1994).** Chromosome numbers of some higher plants taxa of the flora of Krasnoyarsk region. *Botanicheskii Zhurnal (Moscow & Leningrad)*, **79**(2), 135-139.
- Strid, A. & Anderson, I.A. (1985).** Chromosome numbers of Greek mountain plants. *Botanische Jahrbücher für Systematik*, **107**, 206.
- Strid, A. & Franzén, R. (1983).** Chromosome numbers in flowering plants from Greece. *Willdenowia*, **13**, 329-332.
- Syed, S.N., Rizvi, W., Kumar, A., Khan, A.A., Moin, S. & Khan, P.A. (2014).** Study to evaluate the antioxidant and hepatoprotective activities of roots extracts of *Doronicum hookeri* in CCl<sub>4</sub> treated rats. *European Journal of Medicinal Plants*, **4**(6), 675-685. DOI: [10.9734/EJMP/2014/4683](https://doi.org/10.9734/EJMP/2014/4683).
- Tasenkevitch, L.A., Vysotskaja, E.I. & Vorobetz, N.K. (1989).** Chromosome numbers in rare and endemic species of vascular plants from the Ukrainian Carpathians. *Botanicheskii Zhurnal*, **74**, 1669-1670.
- Ugurlu, E. & Secmen, O. (2007).** Medicinal plants popularly used in the villages of Yunt Mountain (Manisa-Turkey). *Fitoterapia*, **79**(2), 126-131. DOI: [10.1016/j.fitote.2007.07.016](https://doi.org/10.1016/j.fitote.2007.07.016).
- Umdu, Ü. (2005).** *Doğu Karadeniz bölgesinde yayılış gösteren Doronicum L. (Compositae) türlerinin morfolojik, palinolojik ve sitolojik yönden incelenmesi*. Doktora Tezi, Karadeniz Teknik Üniversitesi Fen Bilimleri Enstitüsü. Trabzon, Türkiye, 173p.
- Van Loon, J.C. (1980).** IOPB chromosome number reports. *Taxon*, **29**, 720.
- Van Loon, J.C. & Oudemans, J.J.M.H. (1982).** IOPB chromosome number reports. *Taxon*, **31**, 343-344.
- Vir Jee, U.D. & Kachroo, P. (1989).** Cytogeography of some endemic taxa of Kashmir Himalaya. *Proceedings of the Indian National Science Academy. Part B, Biological Sciences*, **3**, 177-184.
- Vladimirov, V., Coşkunçelebi, K. & Tan, K. (2015).** A new diploid species of *Pilosella* Asteraceae) from Turkey. *Turkish Journal of Botany*, **39**, 70-75. DOI: [10.3906/bot-1401-92](https://doi.org/10.3906/bot-1401-92)
- Woodland, D.W. (1997).** *Contemporary Plant Systematics*. Andrews University Press, USA.
- Zhukova, P.G. (1967).** Karyology of some plants, cultivated in the Arctic-Alpine Botanical Garden. In: Avrorin NA (ed.), *Plantarum in Zonam Polarem Transportatio II*, pp. 139-149, Leningrad.