

NEW CHROMOSOME COUNTS IN COUSINIA (ASTERACEAE, CARDUEAE) SECTIONS CYNAROIDEAE AND STENOCEPHALAE FROM IRAN

S. B. Djavadi

Received 18.05.2011. Accepted for publication 21.02.2012.

Djavadi, S. B. 2012 06 30: New chromosome counts in *Cousinia* (Asteraceae, Cardueae) sections *Cynaroideae* and *Stenocephalae* from Iran. –*Iran. J. Bot.* 18 (1): 86-93. Tehran.

Meiotic chromosome counts are reported for eight species of *Cousinia* belonging to sections *Cynaroideae* Bunge and *Stenocephalae* Bunge. All counts are new to science. The new count for *C. recurvata* (sect. *Stenocephalae*), modified the previous count and shows a uniform basic chromosome number of $x = 13$ for the section. Our chromosome counts for the sect. *Cynaroideae* also support the unique basic chromosome number of $x = 12$ within the section.

Seyedeh Bahereh Djavadi <sb_djavadi@hotmail.com>, Department of Botany, Iranian Research Institute of Plant Protection, P. O. Box 1454, Tehran 19395, Iran.

Key words. Chromosome number, new reports, *Cousinia*, Iran.

شمارش کروموزومی جدید از جنس *Cousinia* (sect. *Stenocephalae*, *Cynaroideae*) در ایران

سیده باهره جوادی، مربی پژوهش مؤسسه تحقیقات گیاهپزشکی کشور.

عدد کروموزومی هشت گونه از جنس *Cousinia* متعلق به دو بخشه *Cynaroideae* Bunge و *Stenocephalae* Bunge برای اولین بار گزارش می‌گردد. شمارش کروموزومی جدید انجام شده برای گونه *C. recurvata* از بخشه *Stenocephalae*، گزارش کروموزومی قبلی را اصلاح نموده و نشان می‌دهد که عدد کروموزومی منحصر به فرد در این بخش $x = 13$ می‌باشد. اعداد کروموزومی گزارش شده در این مقاله در خصوص بخش *Cynaroideae* در واقع تاییدی بر وجود تنها یک عدد کروموزومی، $x = 12$ در این بخش است.

INTRODUCTION

The genus *Cousinia* Cass. (Asteraceae) with 600-700 species (Susanna & Garcia-Jacas 2006) is one of the largest genera of the family Asteraceae, and also one of the larger genera of flowering plants (Frodin 2004). *Cousinia* is also the largest genus of the *Arctium* group of the tribe Cardueae subtribe Carduineae (Mabberley 1990, Häffner 2000, Susanna et al. 2003 a, b), which also includes genera *Arctium* L. (11 species), *Hypacanthium* Juz (3 species) and the monotypic genus *Schmalhausenia* C. Winkl. All members of the *Arctium* group are characterized by the following morphological characteristics: twisted scale of receptacle, tigrine surface of achenes, missing nectar and deciduous pappus (Susanna et al. 2003b).

Cousinia as a part of the *Arctium-Cousinia* complex consists of three subgenera (Tscherneva 1988): *C. subg. Cousinia* (c. 600 species), *C. subg. Cynaroides* Tscherneva (c. 20 species) and *C. subg. Hypacanthodes* Tscherneva (c. 10 species). Several recent researches (Susanna et al. 2008a, López-Vinyallonga et al. 2009) have shown that the *Arctium* group is monophyletic and

has two clear subdivisions: 1) the arctioid group which contains the genera *Arctium* L., *Hypacanthium* Juz, *Schmalhausenia* C. Winkl., *C. subg. Cynaroides* Tscherneva and *C. subg. Hypacanthodes* Tscherneva., 2) the cousinoid group which includes only *C. subg. Cousinia*, supported by the *Cousinia* pollen type, smooth and oblong pollen grain as well as chromosome numbers of $2n=18, 20, 22, 24,$ and 26 (Susanna et al. 2003b). Whereas, all members of the arctioid group are characterized by a diploid chromosome number of $2n=36$ (Tscherneva 1985) and the *Arctiastrum* pollen type, orbicular and spiny pollen grains (Susanna et al. 2003b).

According to Flora Iranica, *Cousinia* of the region is divided to 12 groups and 57 sections on the basis of plant duration (annual or perennial) and morphological characteristics: plant spiny or not, leaves decurrent or not, shape of leaves, median bracts appendiculate or not, shape of bracts margin (smooth or spinulose), number of flowers per head and corolla color. But, there are many individual species that do not fit into any sections (Rechinger 1972, 1979). On the

basis of new investigations (Mehregan & Assadi 2009, Assadi 2010) some new sections have been considered for the genus and with considering the newly described species, the species number of *Cousinia* in Iran is more than 250, mainly occurred in the mountainous regions of the area (Assadi 2010, Attar & Djavadi 2010, Attar & Maroofi 2010, Attar & Ghahreman 2000, 2002, 2005, 2006 & 2007, Attar et al. 2001, 2002 & 2005, Djavadi & Attar 2005, 2006 & 2009, Djavadi et al. 2006, 2007a & b, 2009; Mehregan & Kadereit 2008 & 2009, Mehregan et al. 2003, Mirtadzadini & Attar 2004, Mehregan & Assadi 2009, Mehregan et al. 2010, Tscherneva et al. 2005).

According to Arnould (1997), interspecific hybridization plays an important role in evolution of plants and it can be resulted in the formation of new taxa. Just like other genera of *Asteraceae* (Stace 1991, Rieseberg 1997), hybridization is also possible in *Cousinia*. New recent investigations show that no hybridization between *Cousinia* and the main clades of the *Arctium-Cousinia* complex was found. Also, there is no hybridization between annual and perennial species of *Cousinia*. But, hybridization can occur between species of different sections belonging to the same clade or different clades (Mehregan & Kadereit 2009). Regarding to literature, some 30 hybrids and ca. 10 intermediate forms in this genus have been reported (Rechinger 1950, 1972 & 1979, Tscherneva 1962, Kamelin 1973, Mehregan & Kadereit 2009). With removing the intermediate forms and considering the number of hybrids only, in the case of all hybrids were correctly identified, interspecific hybridizations in *Cousinia* is c. 7%, which in comparing with the total species number of *Cousinia*, c. 600, is not considerable. This shows that, interspecific hybridizations are not more frequent in *Cousinia* (Mehregan & Kadereit 2009). With attention to the estimated ratio of interspecific hybridizations in *Cousinia* and with considering that no polyploidy has been reported for *Cousinia* yet, therefore it seems that the role of interspecific hybridizations for the evolution and diversity of *Cousinia* is very minor (Mehregan & Kadereit 2009).

Despite of high number of *Cousinia* in Iran with an astonishing number of endemics, there are very few counts in the literature. The main aim of the paper is to contribute to the general knowledge of chromosome counts in this genus.

MATERIALS AND METHODS

Floral buds of living plants were collected and immediately fixed in the Piennar's solution (ethanol; chloroform; propionic acid; 6:3:2 v/v) for 24 hours, transferred to 70% alcohol and stored under

refrigeration. Slides were prepared by the squash technique and cells were stained with 2% acetocarmine. Digital photographs were taken using a Canon camera (G5) mounted on a Zeiss microscope. The herbarium vouchers are preserved in the "IRAN" herbarium (Thiers 2008), table 1.

RESULTS AND DISCUSSION

In this study, the infrageneric classification is based on that of Rechinger, presented in Flora Iranica (Rechinger 1972, 1979).

Cousinia sect. *Cynaroideae* Bunge

Cousinia arakensis Attar & Djavadi

Qom Prov.: Kakan, Fordow, 2160 m, 22.5.2010, Djavadi & Ghanbari 54763 (IRAN), n = 12.

Meiosis showed 12 bivalents at metaphase I (Fig. 1). This is the first chromosome count for this species.

Cousinia ardalensis Attar & Djavadi

Bakhtiari Prov.: Farsan to Shahr-e Kord, Cholicheh, 2065 m, 4.7.2009, Djavadi, Ghanbari & Torabi 53225 (IRAN), n = 12; Bakhtiari Prov.: Farsan, Deh Cheshmeh, Pir-e Ghar, 2060 m, 5.7.2009, Djavadi, Ghanbari & Torabi 53223 (IRAN), n = 12.

In our studies on two populations of this species, besides 12 bivalents at metaphase I, 24 bivalents were observed at anaphase I without segregation (Fig. 2). This count is the first chromosome report for this species.

Cousinia denaensis Attar & Djavadi

Kohkilouyeh va Boyer Ahmad Prov.: Sisakht, Bijan pass, Dena protected region, 2450-3170 m, 3.7.2009, Djavadi, Ghanbari & Torabi 53860 (IRAN), n = 12.

Twelve bivalents were observed at metaphase I (Fig. 3) and metaphase II (Fig. 4). This count is the first chromosome count for this species.

Cousinia iranica C. Winkl. & Strauss.

Markazi Prov.: Arak, Abbas-abad, Shazand, Rasvand mountains, 2000 m, 26.5.2010, Djavadi & Ghanbari 54766 (IRAN), n = 12.

Meiosis showed 12 bivalents at metaphase I (Fig. 5). Chromosome segregation at anaphase I was 12-12 (Fig. 6). This is the first chromosome count for this species.

Cousinia straussii Hausskn. & C. Winkl.

Markazi Prov.: Arak, Moudar, 1830 m, 26.5.2010, Djavadi & Ghanbari 54765 (IRAN), n = 12.

In this species, meiosis showed 12 bivalents at metaphase I (Fig. 7), which is the first chromosome count for this species.

Section *Cynaroideae* Bunge with ca. 90 species (Tscherneva 1962, Rechinger 1972, 1979, Huber-Morath 1975, Attar & Ghahreman 2006, Attar & Djavadi 2010) is the largest section of the genus *Cousinia*. All members belonging to this section are Irano-Turkestanian elements and have a very limited

Table 1. Chromosome number in *Cousinia* sect. *Cynaroideae* Bunge.

Taxon	Previous count	Present count	References
<i>C. arakensis</i>		n = 12	
<i>C. ardalensis</i>		n = 12	
<i>C. bekeri</i>	n = 18		Chuksanova
<i>C. barbeyi</i>	n = 12		Djavadi & Attar 2010
<i>C. behboudiana</i>	n = 12		Ghaffari et al. 2006
<i>C. calocephala</i>	n = 12		Ghaffari 1986 & 1987, Ghaffari et al. 2000
<i>C. canescens</i>	2n = 24		Susanna et al. 2003
<i>C. concinna</i>	n = 12		Djavadi & Attar 2010
<i>C. cybolepis</i>	n = 12		Ghaffari et al. 2000
<i>C. denaensis</i>		n = 12	
<i>C. farsistanica</i>	n = 12		Djavadi & Attar 2010
<i>C. hamadanensis</i>	n = 12		Ghaffari et al. 2000
<i>C. iranica</i>		n = 12	
<i>C. keredjensis</i>	n = 12		Ghaffari et al. 2006
<i>C. khoramabadensis</i>	n = 12		Ghaffari et al. 2000
<i>C. kirrindica</i>	2n = 24		Afzal-Rafii 1980
<i>C. kornhuberi</i>	2n = 24		Aryavand 1975, Afzal-Rafii 1980
<i>C. kotschyi</i>	2n = 24		Afzal-Rafii 1980
<i>C. lactiflora</i>	n = 12		Ghaffari et al. 2000
<i>C. lordeganensis</i>	n = 12		Djavadi & Attar 2010
<i>C. lyrata</i>	2n = 24		Tcherneva 1985
<i>C. onopordioides</i>	2n = 24, n = 12		Tcherneva 1985, Ghaffari et al. 2006
<i>C. pergamacea</i>	n = 12		Djavadi & Attar 2010
<i>C. phyllocephala</i>	n = 12		Ghaffari et al. 2000
<i>C. purpurea</i>	2n = 24		Susanna et al. 2003
<i>C. sagittata</i>	n = 12		Ghaffari et al. 2000
<i>C. straussii</i>		n = 12	
<i>C. subinflata</i>	2n = 24		Afzal-Rafii 1980
<i>C. verbascifolia</i>	2n = 24, n = 12		Ghaffari 1984, Ghaffari et al. 2000
<i>C. zardkuhensis</i>	n = 12		Djavadi & Attar 2010

distribution area (Rechinger 1986), distributed in Iran (77 species, Attar & Djavadi 2010), Iraq (17 species, Rechinger 1972, 1979), Turkey (8 species, Huber-Morath 1975), former Soviet Union (7 species, Tscherneva 1962), Lebanon & Syria (3 species, Post 1933), Afghanistan (1 species, Rechinger 1972) and Pakistan (1 species, Rechinger 1972). It seems that Iran is the diversity center of the section, so that toward the west and east the number of species is sharply reduced. All members of this section are characterized by decurrent leaves and appendiculate bracts. The section is almost well known from cytological point of view. On the basis of our results and those of other authors (Aryavand 1975, Afzal-Rafii 1980, Ghaffari 1986 & 1987, Tscherneva 1985, Ghaffari et al. 2000 & 2006, Susanna et al. 2003b, Djavadi & Attar 2010), which is summarized in Table 1, it seems that this section has only one basic chromosome number, $x = 12$. There is only one exception of *C. beckeri* Trautv., which has $2n = 18$ according to Chuksanova in Fedorov (1969), which seems to be erroneous.

Cousinia sect. Stenocephalae Bunge

Cousinia recurvata DC.

Bakhtiari prov.: Broujen, Faradonbeh, 2170 m, 21.6.2010, Djavadi & Ghanbari 54480 (IRAN), $n = 13$. Meiosis showed 13 bivalents at metaphase I (Fig. 8). This count disagrees with the previous report of $n=12$ and $2n=24$ by Afzal-Rafii (1980).

Cousinia tenuiramula Rech. f.

Esfahan prov.: between Zarrin Shahr and Shar-e Kord, 1860 m, 21.6.2010, Djavadi & Ghanbari 54482 (IRAN), $n = 13$.

Besides, thirteen bivalents observed at metaphase I, chromosome segregation at anaphase I was 13-13 (Fig. 9). This is the first chromosome count for this species.

Cousinia thamnoides Boiss. & Hausskn.

Esfahan prov.: Ferydon Shahr, Choghyourt, 2820 m, 20.6.2010, Djavadi & Ghanbari 54479 (IRAN), $n = 13$. Meiosis showed 12-12 + 12-12 monad segregation at anaphase II (Fig. 10). This is the first chromosome count for this genus.

Cousinia sect. *Stenocephalae* Bunge with nearly 40 species is the third largest section of *Cousinia* after sections *Cynaroideae* Bunge and *Alpinae* Bunge and the second largest section of the genus in Iran (Tscherneva 1962, Rechinger 1972 & 1979, Huber-Morath 1975, Djavadi & Attar 2006, Attar et al. 2005). The species belonging to this section are distributed in southwestern Asia from Turkmenistan to Lebanon. Iran comprises so far 29 species, out of which 26 are entirely endemic to the area. In the Flora of USSR, this section is divided to three series, including seven

species (Tscherneva 1962). But on the basis of Rechinger's classification, only species belonging to the series *Hypopolis* Tscherneva, are considered within the section *Stenocephalae* Bunge (Tscherneva 1962, Rechinger 1972). Turkey has four species (Huber-Morath 1975), Syria with three species and Iraq and Lebanon each has only one species. Therefore, it seems that Iran is the centre of diversity of this section too. *Cousinia* sect. *Stenocephalae* Bunge is cytologically well known (Table 2). According to our results and those of other authors (Afzal-Rafii 1980, Tscherneva 1985, Ghaffari 1986, Ghaffari & Chariat-Panahi 1985, Ghaffari & Djavadi 1998, Djavadi 2005, Ghaffari et al. 2006, Djavadi 2007, Djavadi & Attar 2010), it seems that this section has only one basic chromosome number, $x = 13$. There are only two counts, which oppose with the other counts within the section: $n = 12$ and $2n = 24$ in *C. recurvata* DC. by Afzal-Rafii (1980) and $2n = 18$ in *C. hypopolia* Bornm. & Sint. by Chuksanova (see Fedorov, 1969). The new count for *C. recurvata* (present study) and *C. hypopolia* (Djavadi & Attar 2010) is $n=13$.

ACKNOWLEDGEMENTS

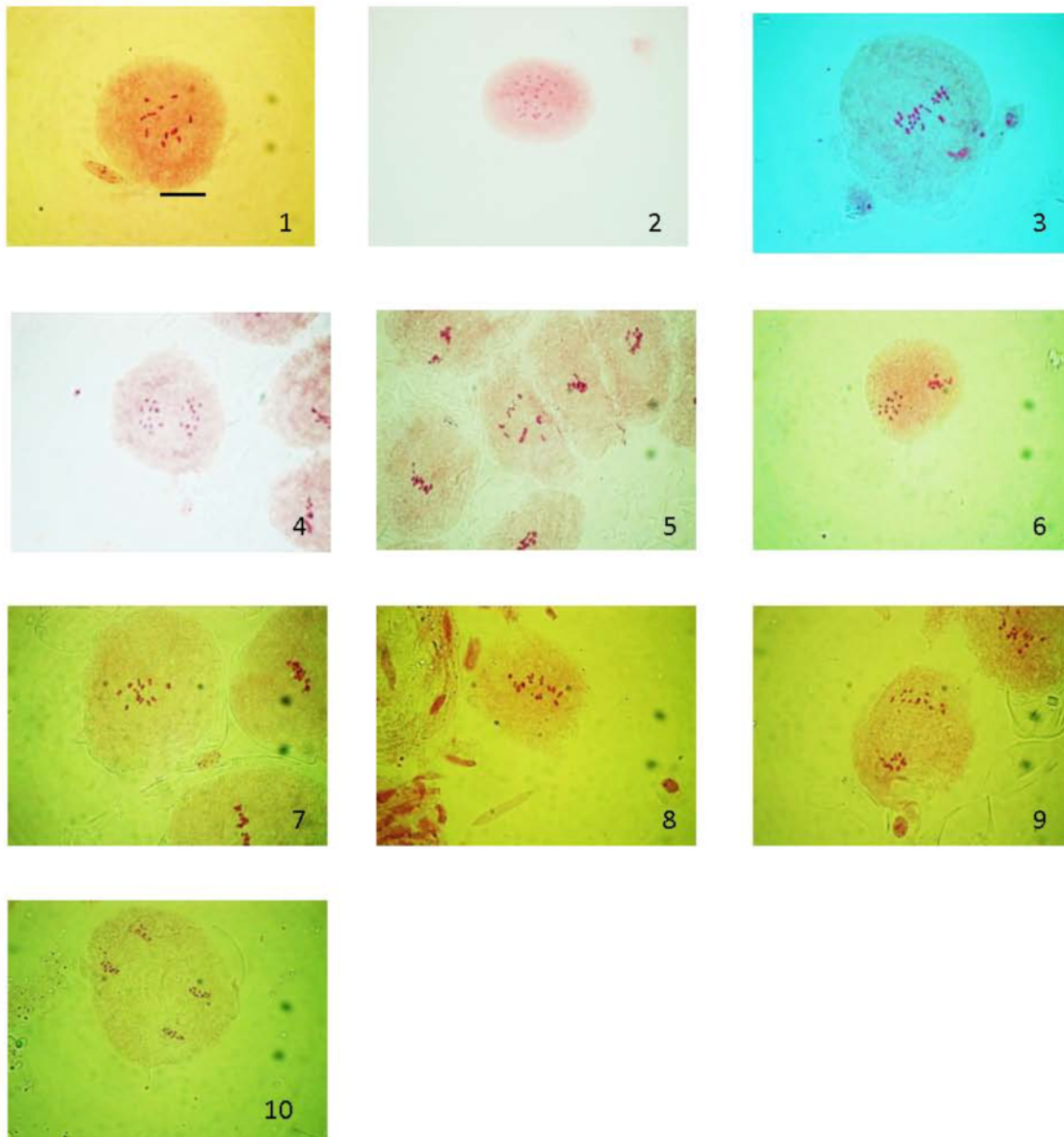
My great thanks to Z. Ghanbari for her kind helps with the field collections.

REFERENCES

- Afzal-Rafii Z. 1980: Contribution à l'étude cytotaxonomique de quelques *Cousinia* d'Iran. - Rev. Biol. Ecol. Medit. 7: 6-14.
- Arnold M. L. 1997: Natural Hybridization and Evolution. -Oxford.
- Aryavand A. 1975: Contribution à l'étude cytotaxonomique de quelques angiospermes de l'Iran. -Botaniska Notiser 128 : 299-311.
- Assadi M. 2009: Four new species of *Cousinia* Cass. (Asteraceae) from Iran. -Iranian Journal of Botany 15 (1): 36-44.
- Assadi M. 2010: A taxonomic revision of *Cousinia* sect. *Chaetocephalae* (Asteraceae). -Iranian Journal of Botany 16 (2): 191-196.
- Attar, F. 2000: The systematic study of *Cousinia* (Asteraceae) sect. *Cynaroideae* in Iran. -Ph. D dissertation, Faculty of Sciences, Tehran University, Tehran.
- Attar F. & Djavadi S. B. 2010: A taxonomic revision of *Cousinia*, sect *Cynaroides* (Asteraceae, Cardueae) in the flora of Iran. -Iranian Journal of Botany 16 (1): 130-184.
- Attar F. & Ghahreman A. 2000: Two new species and a new record of the genus *Cousinia* Cass. sect.

Table 2. Chromosome number in *Cousinia* sect. *Stenocephalae* Bunge.

Taxon	Previous count	Present count	References
<i>C. aggregata</i>	n = 13		Ghaffari & Djavadi 1998
<i>C. albiflora</i>	n = 13		Tscherneva 1985
<i>C. alexeenkoana</i>	n = 13		Ghaffari et al. 2006
<i>C. assyriaca</i>	n = 13		Ghaffari & Djavadi 1998
<i>C. bijarensis</i>	n = 13		Djavadi & Attar 2010
<i>C. calolepis</i>	n = 13		Ghaffari & Djavadi 1998
<i>C. commutata</i>	2n = 26, n = 13		Afzal-Rafii 1980, Ghaffari & Djavadi 1998
<i>C. cylindracea</i>	n = 13		Ghaffari & Djavadi 1998
<i>C. decipiens</i>	n = 13		Djavadi 2007
<i>C. esfandiarii</i>	n = 13		Djavadi 2007
<i>C. gaubae</i>	n = 13		Ghaffari 1986, Ghaffari & Chariat-Panahi 1985, Ghaffari & Djavadi 1998
<i>C. glaucopsis</i>	n = 13		Ghaffari & Djavadi 1998
<i>C. hypopolia</i>	2n = 18, n = 13		Chuksanova, Djavadi & Attar 2010
<i>C. lucida</i>	2n = 26, n = 13		Afzal-Rafii 1980, Ghaffari et al. 2006
<i>C. nekarmanica</i>	n = 13		Ghaffari & Djavadi 1998
<i>C. prasina</i>	n = 13		Djavadi 2005
<i>C. recurvata</i>	n = 12	n = 13	Afzal-Rafii 1980
<i>C. renominata</i>	n = 13		Djavadi & Attar 2010
<i>C. stahlia</i>	n = 13		Djavadi & Attar 2010
<i>C. tenuiramula</i>		n = 13	
<i>C. thamnodes</i>		n = 13	



Figs. 1-10. Meiosis in *Cousinia* spp.- 1: *C. arakensis*, metaphase I, $n = 12$; 2: *C. ardalensis*, anaphases I without segregation (24); 3-4: *C. denaensis*, metaphase I and metaphase II, $n = 12$; 5-6: *C. iranica*, metaphase I, $n = 12$ and anaphase I (12-12); 7: *C. straussii*, metaphase I, $n = 12$; 8: *C. recurvata*, metaphase I, $n = 13$; 9: *C. tenuiramula*, anaphase I (13-13); 10: *C. thamnoides*, anaphase II, showing 13-13 + 13-13 monad segregation.- Scale bar = 10 μm .

Cynaroideae (Asteraceae) from west of Iran. -Iranian Journal of Botany 8 (2): 259-269.

Attar F. & Ghahreman A. 2005: Two new species of the genus *Cousinia* (Asteraceae) from Iran. -Nordic Journal of Botany 23(4): 589-592.

Attar F. & Ghahreman A. 2006: A synopsis of sect. *Cynaroides* (*Cousinia*, Compositae), distribution

patterns and diversity centers. -Rostaniha 7 (Suppl. 2): 315-342.

Attar, F. & Maroofi, H. 2010: *Cousinia* (sect. *albidae*) *iranshahriana* (Asteraceae, Cardueae), a new endemic species from Kurdistan province, Iran. - Iranian Journal of Botany 16 (2): 197-199.

Attar F. & Mirtadzadini M. 2009: Two new species of *Cousinia* Cass. sect. *Pugioniferae* Bunge

- (Asteraceae, Cardueae), from east and southeast of Iran. -Iranian Journal of Botany 15 (2): 146-152.
- Attar F. & Ghahreman A. 2007: *Cousinia aligudarzensis* (Asteraceae), a new species of section *Cynaroidea* Bunge from Iran. -Novon 17: 145-147.
- Attar F., Ghahreman A. & Assadi M. 2001: Studies on the genus *Cousinia* Cass. (Compositae) in Iran. -Iranian Journal of Botany 9 (1): 55-62.
- Attar F., Ghahreman A. & Assadi M. 2002: *Cousinia zagrica* (Asteraceae), a new species from West of Iran. -Sendtnera 8: 5-7.
- Attar F., Ghahreman A., Saber A. & Zarre Sh. 2005: A new species of the genus *Cousinia* (Compositae, sect. *Stenocephalae*) From SW of Iran. -Iranian Journal of Botany 11(1): 65-69.
- Djavadi S. B. 2005: New or rare chromosome counts in 10 species of *Cousinia* from Iran (I). -Rostaniha 6: 61-70.
- Djavadi S. B. 2007: New or rare chromosome counts in 10 species of *Cousinia* from Iran (II). -Rostaniha 8: 19-27.
- Djavadi S. B. & Attar F. 2005: Sect. *Lasiandra* from genus *Cousinia* Cass. (Compositae) with emphasis to a new species from east of Iran. -Feddes Repertorium 116 (5-6): 285-289.
- Djavadi S. B. & Attar F. 2006: Two new species of *Cousinia* Cass. of sect. *Stenocephalae* Bunge from Iran. -Feddes Repertorium 117 (7-8): 453-458.
- Djavadi S. B. & Attar F. 2009: *Cousinia kilouyensis* (Asteraceae, Cardueae), a new endemic species from SW Iran. -Willdenowia 39: 89-92.
- Djavadi S. B., Attar F. & Eskandari M. 2006: Two new species of the genus *Cousinia* from Iran. -Rostaniha 7 (Suppl. 2): 165-175.
- Djavadi S. B., Attar F. & Eskandari M. 2009: Section *Neurocentra* Bunge from genus *Cousinia* Cass. (Asteraceae) in Iran. -Feddes Repertorium 120 (1-2): 27-34.
- Djavadi S. B., Attar F. & Eskandari M. 2007a. *Cousinia papillosa*, a new species from eastern Iran, including chromosome count and palynological studies. Rostaniha 8 (2): 63-73.
- Djavadi S. B., Attar F. & Najafi Z. 2007b: A new species of *Cousinia* sect. *Cousinia* from NW Iran. -Iranian Journal of Botany 13 (1): 43-46.
- Djavadi S. B. & Attar F. 2010: New chromosome counts in the genus *Cousinia* (Asteraceae, Cardueae) from Iran. -Willdenowia 40: 351-357.
- Fedorov A. A. (ed.) 1969: Chromosome Numbers of Flowering Plants. -Leningrad: Nauka (in Russian).
- Frodin D. G. 2004: History and concepts of big plant genera. -Taxon 53: 753-776.
- Ghaffari S. M. 1986: Chromosome number reports XCIII. -Taxon 35: 897-903.
- Ghaffari S. M. 1987: Chromosome studies in some flowering plants of Iran. -Rev. Cytol. Biol. Veg., Bot. 10: 3-8.
- Ghaffari S. M. & Chariat-Panahi, S. 1985: Chromosome count of some Angiosperms from Iran. -Iranian Journal of Botany 3 (1): 67-73.
- Ghaffari S. M. & Djavadi S. B. 1998: Chromosome studies and distribution of nine species of *Cousinia* section *Stenocephalae* (Asteraceae) in Iran. -Bulletin De La Société Neuchâteloise Des Sciences Naturelles 121: 61-68.
- Ghaffari S. M., Attar F. & Ghahreman A. 2000: Distribution and chromosome studies on some species of *Cousinia* Cass. (sect. *Cynaroidea*) from Iran. -Pakistan Journal of Botany 32: 311-316.
- Ghaffari S. M., Garcia-Jacas N. & Susanna A. 2006: New chromosome counts in the genus *Cousinia* (Asteraceae) from Iran. -Botanical Journal of the Linnean Society 151: 411-419.
- Häffner E. 2000: On the phylogeny of the subtribe *Carduinae* (tribe *Cardueae*, *Compositae*). -Englera 21.
- Huber-Morath, A. 1975: *Cousinia* in P. H. Davis (ed.), Flora of Turkey and the East Aegean Islands, vol. 5: 329-353. -Edinburgh at the University Press.
- López-Vinyallonga S., Mehregan I., Garcia-Jacas N., Tscherneva O. Susanna A. & Kaderiet J. W. 2009: Phylogeny and evolution of the *Arctium-Cousinia* complex (Compositae, Cardueae- *Carduinae*). -Taxon 58: 153-171.
- Mabberley, D. J. 1990: The Plant Book. -Cambridge, UK. Cambridge University Press.
- Mehregan I. & Assadi M. 2009: *Cousinia* sect. *Argenteae* (Asteraceae, Cardueae), a new section including a new species from NE Iran. -Willdenowia 39: 265-271.
- Mehregan I. Assadi M. & Attar F. 2003. *Cousinia* (sect. *Hausknechtianae*) *gatchsaranica*, a new species from SW Iran. Willdenowia 33: 107-111.
- Mehregan I., Djavadi S. B. & Pahlevani A. H. 2010: *Cousinia* (sect. *Hausknechtianae*) *karkasensis*, a new species from Karkas Mts. in central Iran. -Iranian Journal of Botany 16 (2): 200-203.
- Mehregan I. & Kadereit J. W. 2008: Taxonomic revision of *Cousinia* sect. *Cynaroidea* (Asteraceae, Cardueae). -Willdenowia 38: 263-362.
- Mehregan I. & Kadereit J. W. 2009: The role of hybridization in the evolution of *Cousinia* s.str. (Asteraceae, Cardueae). -Willdenowia 39: 35-47.
- Mirtadzadini M. & Attar F. 2004: *Cousinia* (sect. *Spinuliferae*) *hazarensis* (Compositae, Cardueae), a

- new species from SE Iran. -*Willenowia* 34: 191-194.
- Rechinger K. H. 1950: *Cousinia novae iranicae*. -*Ann. Naturhist. Mus. Wien* 57: 71-84.
- Rechinger K. H. 1972: *Compositae-Cynareae I. Cousinia* in K. H. Rechinger (ed.). *Flora Iranica*, no. 90. -Graz.
- Rechinger K. H. 1979: *Compositae III-Cynareae. Cousinia* in K. H. Rechinger (ed.) *Flora Iranica*, no. 139a: 108-153. -Graz.
- Rechinger K. H. 1986: *Cousinia: morphology, taxonomy, distribution and phytogeographical implication*. -*Proceedings of the Royal Society of Edinburgh* 89 B: 45-58.
- Rieseberg L. H. 1997: Hybrid origins of plant species. -*Annual Review of Ecology Evolution and Systematics* 28: 359-389.
- Stace C. A. 1991: *New Flora of the British Isles*. -Cambridge.
- Susanna A. & Garcia-Jacas N. 2006 ["2007"]. Tribe *Cardueae* Cass. (1819) in Kadereit J. W. & Jeffrey C. (volume ed.), *the Families and Genera of Vascular Plants* 8: 123-147. -Berlin, etc.
- Susanna A., Garcia-Jacas N., Vilatersana R. & Garnatje T. 2003a: Generic boundaries and evolution of characters in the *Arctium* group: a nuclear and chloroplast DNA analysis. -*Collectanea Botanica, Barcelona* 26: 101-118.
- Susanna A., Garcia-Jacas N., Vilatersana R., Garnatje T., Valles J. & Ghaffari S. M. 2003b: New chromosome counts in the genus *Cousinia* and the related genus *Schmalhausenia* (Asteraceae, Cardueae). -*Botanical Journal of the Linnean Society* 143: 411-418.
- Thiers B. 2008+ [continuously updated]: *Index herbariorum. A global directory of public herbaria and associated staff*. - <http://sweetgum.nybg.org/ih/>
- Tscherneva O. V. [Cherneva O. V.] 1962: *Compositae-Cousinia* in Shishkin B. K. & Bobrov E. G. (ed.), *Flora SSSR* 27: 108-357. -Moscow & Leningrad [English translation: Enfield. 1993].
- Tscherneva O. V. 1985: Chromosome number in the species of the genus *Cousinia* (Asteraceae) in the flora of the USSR. -*Botaniceskij Zurnal* 70: 856-857 (in Russian).
- Tscherneva O. V. [Cherneva O. V.] 1988: *Konspekt sistemy roda Cousinia (Asteraceae) flory SSSR* [Synopsis of the system of the genus *Cousinia* (Asteraceae) in the flora of the USSR]. -*Botanicheskii Zhurnal (Moscow & Leningrad)* 73: 870-876.
- Tscherneva, O. V., Joharchi, M. & Ghahremani-Najad, F. 2005: A new species of the genus *Cousinia* (Asteraceae) from Iran. -*Botanical Journal* 90: 411-414.