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**Chromosome studies on some species of Angiosperms from Iran**

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Original observation on meiotic or mitotic chromosome numbers are reported for 17 taxa in nine families of Angiosperms plant from Iran including: *Ammi majus* (n=11), *Anthemis pseudocotula* (n=9), *Centaurea kotschy* var. *persica* (n=27, 2n=54), *Jurinea macrocephala* (n=17), *Scorzonera cana* (n=7), *Scorzonera raddeana* (n=6), *Physorrhynchus chamaerapistrum* (n=16), *Onosma rostellatum* (n=12), *Silene conoidea* (n=10), *Umbilicus tropaeolifolius* (n=18), *Polygala hohenackeriana* (n=7), *Batrachium rionii* (n=8), *Hyoscyamus leucanthera* (n=17), *Hyoscyamus niger* (n=17), *H. pusillus* (n=34), *H. reticulatus* (n=17), *H. senecionis* var. *bipinnatisectus* (n=34). Chromosome count for six species: *H. senecionis* var. *bipinnatisectus*, *Onosma rostellatum*, *H. leucanthera*, *Polygala hohenackeriana*, *Scorzonera raddeana*, and *Umbilicus tropaeolifolius* are reported here for the first time and four counts including *Ammi majus*, *Centaurea kotschy* var. *persica*, *Scorzonera cana*, and *Batrachium rionii* is new for the flora of Iran.

**Keywords:** Chromosome count, flora, meiosis, mitotic, new report**مطالعات کروموزومی روی تعدادی گونه نهندانه از ایران**

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**خلاصه**

شمارش‌های کروموزومی تقسیمات میتوزی و یا میوزی روی ۱۷ آرایه متعلق به نه تیره شامل *Ammi majus* (n=11)، *Jurinea macrocephala* (n=17)، *Centaurea kotschy* var. *persica* (n=27, 2n=54)، *Anthemis pseudocotula* (n=9)، *Onosma rostellatum*، *Physorrhynchus chamaerapistrum* (n=16)، *Scorzonera raddeana* (n=6)، *Scorzonera cana* (n=7)، *Polygala hohenackeriana* (n=7)، *Umbilicus tropaeolifolius* (n=18)، *Silene conoidea* (n=10)، *H. pusillus* (n=34)، *Hyoscyamus niger* (n=17)، *Hyoscyamus leucanthera* (n=17)، *Batrachium rionii* (n=8)، *H. reticulatus* (n=17) و *H. senecionis* var. *bipinnatisectus* (n=34) انجام شد که از این تعداد، شمارش کروموزومی شش گونه شامل *Polygala hohenackeriana*، *H. leucanthera*، *Onosma rostellatum*، *H. senecionis* var. *bipinnatisectus* و *Scorzonera raddeana* و *Umbilicus tropaeolifolius* برای نخستین بار گزارش می‌شود. همچنین، شمارش کروموزومی چهار گونه شامل *Ammi majus*، *Centaurea kotschy* var. *persica*، *Scorzonera cana* و *Batrachium rionii* برای فلور ایران جدید است.

**واژه‌های کلیدی:** تقسیم میتوز، تقسیم میوز، شمارش کروموزومی، فلور، گزارش جدید

## Introduction

This is the third of a series of paper dealing with chromosome counts of some Angiosperms from Iran (Ghaffari 1987, 2006). The flora of Iran comprises ca. 8000 flowering plant species. So far, about 2500 plant species have been chromosomally counted (Ghaffari 2020). Since chromosomal information is useful in the systematic botany and plant breeding, therefore, chromosomes counting is the first step towards a better understanding of the karyotype evolution and the role of chromosome evolution in the plant species. The present study, describes the meiotic or mitotic chromosome numbers of 17 species in nine families of Angiosperms.

## Materials and Methods

Plants were collected from different parts of Iran (results are shown below). Actively growing root tips were used for mitotic analysis. For this purpose, roots were 6%, chloroform, propionic acid, 6:3:2 V/V). Staining was carried out with acetocarmine. Voucher specimens were deposited at the Central Herbarium of Tehran University (TUH), Tehran (Iran).

## Results and Discussion

### *Apiaceae*

#### *Ammi majus* L.

Khuzestan province: Dezful to Safiabad

Flora of Iran possesses two species of the genus *Ammi*, including *A. majus* and *A. visnaga*. *Ammi majus* is distributed world-widely (Mozaffarian 2007). Our sample was diploid with gametic chromosome number of  $n=11$ , which agrees with the previous reports of  $2n=22$  (see Fedorov 1974). Meiosis in this species was regular and showed 11 bivalents at diakinesis (Fig. 1A). This count is new for the flora of Iran.

### *Asteraceae*

#### *Anthemis pseudocotula* Boiss.

Khuzestan province: Dezful, Sardasht

Meiosis in this species was regular and showed nine bivalents at diakinesis (Fig. 1B), which agrees with

the previous report of Yousofzadeh *et al.* (2010) in somatic cells ( $2n=18$ ) from Isfahan (Iran).

#### *Centaurea kotschy* (Boiss. & Heldr.) Hayek var. *persica* (Boiss.) Wagenitz

Qazvin province: Abgarm towards Avaj

*Centaurea kotschy* belongs to section *Cheirolepis* and distributed in Iran, Anatolia, and Caucasus. Meiosis in this taxon was regular and showed 27 bivalents at metaphase I (Fig. 1C). Most of bivalents appeared in rod shape. The somatic chromosome number at metaphase in this species was  $2n=54$  (Fig. 1D), which agrees with meiosis count. This count is new for flora of Iran.

#### *Jurinea macrocephala* DC.

Qazvin province: between Avaj toward Abgarm

*Jurinea* is represented by 37 species in the Flora Iranica area, of which 25 species belong to Iran (Rechinger & Wagenitz 1979).

Previous somatic chromosome number of  $2n=34$  is reported by Parishani *et al.* (2014) from Isfahan, Chadegan (Iran), which agrees with the present count ( $n=17$ ) on the pollen mother cells (Fig. 1E).

#### *Scorzonera cana* (C.A. Mey.) O. Hoffm.

Alborz province: Karaj, Shahdasht

This species was diploid with gametic chromosome number of  $n=7$  (Fig. 1F), which agrees with previous reports (Kuzmanov & Georgieva 1983, Dimitrova 1999). This count is new for the flora of Iran.

#### *S. raddeana* C. Winkl.

Alborz province: Karaj, Taleghan, Kalanak

*Scorzonera* L. is a genus with 61 species in Flora Iranica (Rechinger 1977), of which 52 species are recorded to Iran. According to literatures, two basic chromosome numbers of  $x=6$  and  $x=7$  are presented in this genus (Winfield *et al.* 2006, Ghasemi *et al.* 2015). Previous chromosome counts for the genus from Iran are limited to nine species (Ghaffari 1999, Safavi 1999,

Hatami *et al.* 2019). Our sample was diploid with gametic number of  $n=6$ . Meiosis in this species was regular and showed six bivalents at metaphase I, which most of them were in ring type with two or three chiasmata (Fig. 1G). Chromosome segregation at anaphase I was 6-6 and showed two long chromosomes in this stage (Fig. 1H). Recent chromosome count ( $2n=14$ ) by Hatami *et al.* (2019) from Estahban to Neiriz (Fars province, Iran) is questionable!. According to our knowledge, this is the first chromosome number report for this species from Iran.

### **Brassicaceae**

#### ***Physorhynchus chamaerapistrum* Boiss.**

Khuzestan province: south of Ramhormoz

In the Flora Iranica, this taxon mentioned as an endemic species to Iran, but in recent years, this species recorded from Pakistan, Oman, Kuwait, Emirate, and Saudi Arabia. Our sample was diploid and showed 16 bivalent at diakinesis and metaphase I (Fig. 1I). This is the 3rd. count for this species based on  $x=16$ . Two previous counts ( $2n=32$ ) are reported by Gomez-Campo (1978) and Khosravi & Maassoumi (1998) from different parts of Iran.

### **Boraginaceae**

#### ***Onosma rostellatum* Lehm.**

Khuzestan province: Izeh, Eshkaft-e Soleyman

The Flora Iranica possesses 59 species of the genus *Onosma*, of which 47 species belong to Iran. The range of chromosome number in this genus are  $2n=12, 14, 16, 18, 21, 24, 27, 28,$  and  $50$  (Fedorov 1974, Goldblatt 1981–88, Goldblatt & Johnson 1990–2006, Goldblatt & Johnson 2010). Our sample was tetraploid with  $2n=4x=24$ . Meiosis in this species was regular and showed 12 bivalents at metaphase I and 12-12 segregation at anaphase I (Fig. 1J). According to our data, this is the first chromosome count for this species from Iran.

### **Caryophyllaceae**

#### ***Silene conoidea* L.**

Alborz province: Karaj, Taleghan, Samghabad

The flora of Iran, possesses about 110 species of the genus *Silene*, of which 35 species are endemic to Iran. The majority of the references showed that, diploid species ( $2n=2x=20$  or  $2n=2x=24$ ) are more spread than tetraploid ( $2n=4x=48$ ) and hexaploid ( $2n=6x=72$ ) races (Draghia *et al.* 2014). Our sample showed 10 bivalents at diakinesis and metaphase I (Fig. 1K & L). This count agrees with previous reports of Aryavand & Favarger (1980), Ozturk *et al.* (2009), but differs with Ghasemi *et al.*'s (2015) count ( $2n=24$ ).

### **Crassulaceae**

#### ***Umbilicus tropaeolifolius* Boiss.**

Khuzestan province: Izeh, Eshkaft Soleyman

Chromosome count at metaphase I and 18 chromatids segregation at anaphase II showed  $n=18$  in this taxon (Fig. 1M). Previous reports for five species of the genus are  $2n=48$  (Fedorov 1974, Goldblatt 1981–88, Goldblatt & Johnson 1990–2006, Goldblatt & Johnson 2010). This is the first chromosome number report for this species from Iran.

### **Polygalaceae**

#### ***Polygala hohenackeriana* Fisch. & C.A. Mey.**

Tehran province: Tehran, 60 km towards Qom

The range of chromosome number in the genus *Polygala* are  $2n=16, 18, 24, 26, 28, 32, 34, 36, 42, 44, 48,$  and  $68$ . Our sample was diploid and showed seven monads at anaphase II (Fig. 1N). According to our data, this is the first chromosome number report for this species and new basic number of  $x=7$  for the genus from Iran.

### **Ranunculaceae**

#### ***Batrachium rionii* (Lagger) Nym.**

Khuzestan province: Ahwaz, 45 km towards Andimeshk

This species was diploid with gametic chromosome number of  $n=8$  and showed eight bivalents at diakinesis (Fig. 10). This is the 2nd. chromosome count for this species while first chromosome count was reported by Gadnidze *et al.* (1998) from Russian population. This is the first chromosome report of this species for the flora of Iran.

### *Solanaceae*

#### *Hyoscyamus leucanthera* Bornm. & Gauba

Alborz province: Karaj, Shahrestanak

The Flora Iranica possesses 24 species of the genus *Hyoscyamus*, of which 19 species belong to the flora of Iran (Schonbeck-Temesy 1972). Khatamzas (1998) reduced the number of species in 13 taxa. Meiosis in our sample was regular and showed 17 bivalents at metaphase I which more of them were in rod-shape (Fig. 1P). This is the first chromosome number report for this species from Iran.

#### *Hyoscyamus niger* L.

Tehran province: Damavand

This taxon is widely distributed in many parts of Iran. Meiosis in this species was regular and showed 17 bivalent at metaphase I and 17-17 dyads at metaphase II (Fig. 1Q & R). This count agrees with the previous report by Ghaffari (1987) from different parts of Iran.

#### *H. pusillus* L.

Alborz province: Karaj, Mardabad, Halgheh Dareh

Only one report for this species ( $2n=64$ ) is previously reported by Sheidai *et al.* (1999) from Arak (Markazi province, Iran). Our sample was tetraploid and showed 34 bivalents at metaphase I (Fig. 1S). Gametic number ( $n=34$ ) is reported here for the first time from Iran.

#### *H. reticulatus* L.

Qazvin province: Avaj

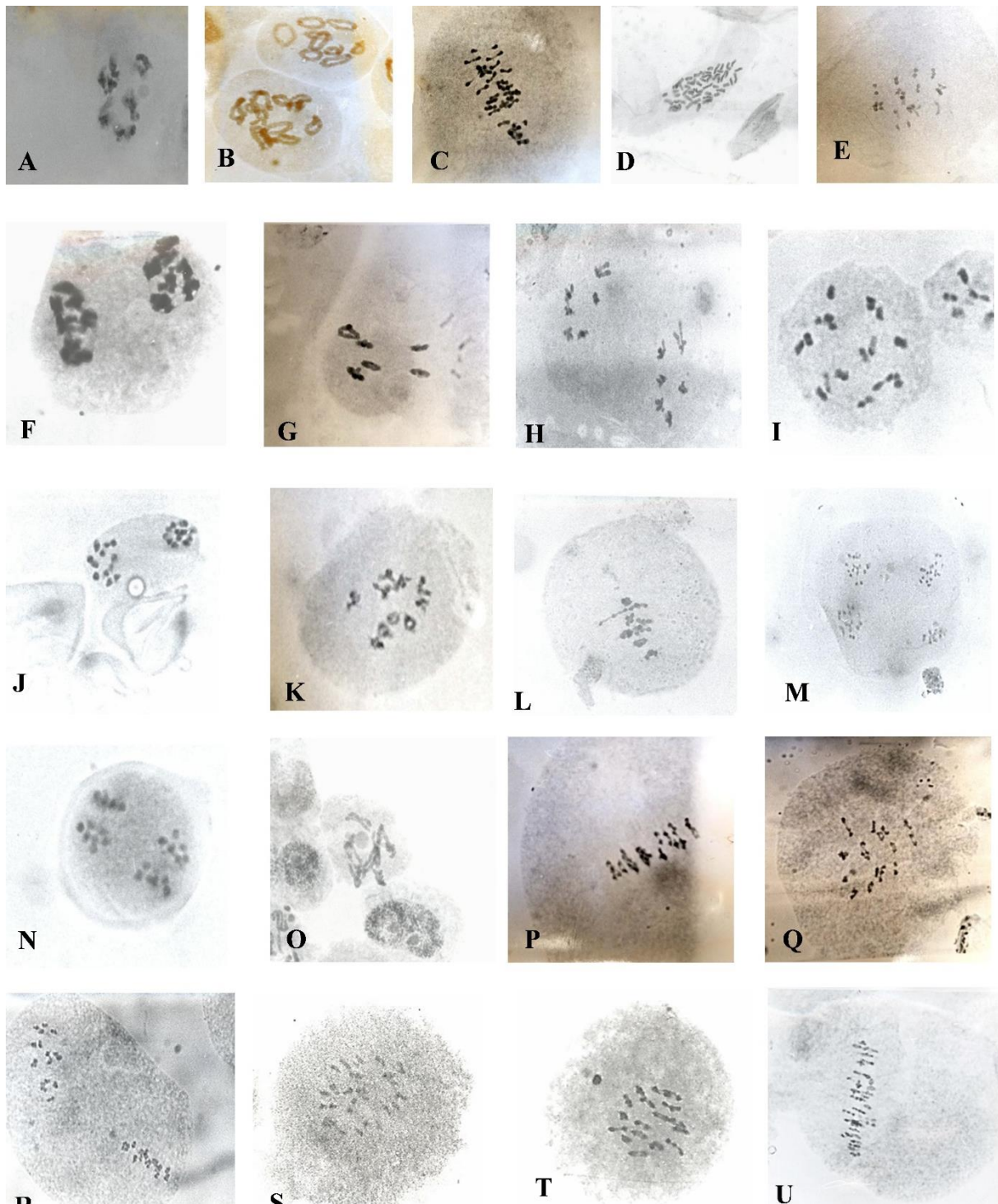
Alborz province: Karaj, Kandovan Mt. & Shahrestanak

Only one report for this species ( $2n=34$ ) is previously reported by Sheidai *et al.* (1999). Meiosis study in three populations of this species were regular and showed 17 bivalents at metaphase I (Fig. 2T).

#### *H. senecionis* var. *bipinnatisectus* (Boiss.) Boiss.

Semnan province: Shahmirzad

Two varieties of this taxon are reported by Khatamsaz (1998) i.e., var. *senecionis* which is cytologically investigated by Sheidai *et al.* (1999), and var. *bipinnatisectus* which is surveyed here. According to literature, the genus *Hyoscyamus* has two basic chromosome numbers i.e.  $x=14$  and  $x=17$  with two races of ploidy (diploidy with  $2n=28$  and  $34$ , tetraploidy with  $2n=56$  and  $68$ ). Frequency of diploid species with  $2n=34$  are more than the other races. Our sample was tetraploid with 34 bivalents, which was observed at metaphase I (Fig. 1U). This is the first chromosome number report for this variety. Previous count ( $2n=2x=34$ ) for var. *senecionis* is reported by Sheidai (1999).



**Fig. 1.** A. *Ammi majus*, diakinesis (n=11), B. *Anthemis pseudocotula*, diakinesis (n=9), C, D. *Centaurea kotschyi*, metaphase of meiosis and mitosis, respectively (n=27, 2n=54), E. *Jurinea macrocephala*, metaphase I (n=17), F. *Scorzonera cana*, metaphase II (n=7), G, H. *S. raddeana*, metaphase and anaphase I (n=6), I. *Physorrhynchus chamaerapistrum*, diakinesis (n=16), J. *Onosma rostellatum*, anaphase I (12-12), K, L. *Silene conoidea*, diakinesis and metaphase I (n=10), M. *Umbilicus tropaeolifolius*, anaphase II (n=18), N. *Polygala hohenackeviana*, anaphase II (n=7), O. *Batrachium rionii*, diploid (n=8), P. *Hyoscyamus leuconthera*, metaphase I (n=17), Q, R. *H. niger*, 1st. and 2nd. metaphase (n=17), S. *H. pusillus*, metaphase I (n=34), T. *H. reticulatus*, metaphase I (n=17), U. *H. senecionis* var. *bipinnatisectus*, metaphase I (n=17) (Bar = 5  $\mu$ m).

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