SOME CHROMOSOME COUNTS AND MEIOTIC BEHAVIOR IN CENTAUREA SPECIES FROM IRAN

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Original chromosome observations of 23 populations representing 11 species, 3 subspecies and 2 varieties are reported. Six are new reports and nine are confirmations or corrections of previous counts. Meiotic behaviour of chromosomes are reported for the first time.

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شمارش کروموزومی و رفتار میوزی در برخی از گونه‌های Centaurea از ایران

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مشاهدات کروموزومی ۲۳ جمعیت متعلق به ۱۱ گونه، ۳ زیرگونه و ۲ واریته گزارش می‌شود. گزارش کروموزومی برای ۶ گونه جدید و برای ۹ گونه دیگر یا تایید و یا تصحیح شده است. رفتار میوزی کروموزومها و فراوانی کیاسما برای اولین بار ارائه گردیده است.

INTRODUCTION

Centaurea is a genus with about 700 species throught the world. In Flora Iranica 88 species belong to 28 sections are reported (Wagenitz,1980), with only 69 species distributed in Iran, 22 of which are endemic. According to Wagenitz (1986) in South West Asia, number of species are the highest in South and East Turkey as well as Iran and Iraq. East of Iran and Afghanistan are poor in species. *Centaurea* is a complex genus with a various range of chromosome numbers (2n=14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 33, 36, 40, 44, 50, 54, 60, 66, 100 and 110). In karyological view, the *Centaurea* is a very heterogenous exhibiting the basic numbers x=7, 8, 9, 10, 11, 12, 13 and 15. In recent years there have been numerous papers reporting chromosome counts for miscellaneous species of *Centaurea* (Georgiadis 1983, Georgiadis & Christodoulakis 1984, Georgiadis *& al.* 1996, Ghaffari 1989, Routsi & Georgiadis 1994, Agabayan & Goukasian 1994, Garcia-Jacas & Susanna 1992, 1997, Garcia-Jacas & *al.* 1998). The present paper decribes chromosome studies for 9 sections including 11 species, 3 subspecies and 2 varieties.

MATERIAL AND METHODS

Chromosome studies carried out on materials collected from various areas of Iran (Table 1). For meiotic studies, young capitula were collected and fixed in freshly prepared Piennar's solution (ethanol 96%, chloroform, propionic acid;6:3:2 V/V) for 24 hrs at room temperature. The slides were prepared by squash technique using acetocarmine as the stain. For mitotic studies root tips were pretreated for three hrs with 0.002 M 8-hydroxyquinoline and then fixed in Piennar's solution. Staining was carried out with the Feulgen reaction enhanced by squashing in 2% acetocarmine. The existence of previous chromosome counts for the studied species has been checked in the indexes of plant chromosome numbers by Fedorov (1969), Goldblatt (1981, 1984, 1985, 1988), Goldblatt & Johnson (1990, 1991, 1994, 1996, 1998), Moore (1982) and Moore (1971, 1972, 1973, 1974, 1977).

RESULTS AND DISCUSSION

Section Centaurea

Centaurea ruthenica Lam.

Chromosome complement in this taxon was 2n=30, which agree with previous reports (Tonjan 1968, Agabayan & Goukasian 1994). The karyotype in this species was symmetric with predominant submetacentric chromosomes, which two of them have clear satellites in short arm (Fig.1).This is the first chromosome number report for flora of Iran. According to literature the basic chromosome number of section *Centaurea* is x=15.

Section Chartolepis

C. pterocaula Trautv. subsp. **iranica** Wagenitz

This subspecies is endemic to Iran. Two collections of this taxon were studied (Table 1), which both of them had n=18 chromosomes. Occasionally in some cells bivalents, tetravalents and hexavalent at first metaphase were observed (Fig.2). This is the first chromosome number report for this taxon. This is a new confirmation of x=9 as the basic chromosome number of section *Chartolepis*.

Section Cynaroides

C. imperialis Haussk. ex Bornm.

This species is endemic to Iran and Iraq. Previous report for this taxon is 2n=2x=18 (Garcia-Jacas & *al.* 1998). Meiosis in this species was regular and

Table 1: The origin of material used in chromosome studies. Gh=Ghaffari, Azar=Azarbaijan Maz=Mazandaran, Teh=Tehran, Lor=Lorestan, Kurd=Kurdistan,

Sections and species	Altitude m	Origin and collector
Sect. *Centaurea*		
C. ruthenica	2400	Azar: Mt. Khalilkuh. Gh:8677.
Sect. *Chartolepis*		
C. pterocaula subsp. *iranica*	1220	Azar: between Mohabad&Orumiyeh Gh:1668.
	1300	Azar: between Bookan & Mahabad Gh:670.
Sect. *Cynaroides*		
C. imperialis	1800	Azar: between Oshnaviyeh & Orumiyeh Gh: 17071
Sect. *Jacea*		
C. hyrcanica	1100	Maz: Kelardasht Gh: 1570.
	2130	Maz: between Ghaemshahr & Firouzkuh Gh: 8167.
Sect. *Microlophus*		
C. polypodiifolia var. *polypodiifolia*	1600	Azar: Mianeh Gh: 19071.
	1530	Azar: between Khoy & Salmas Gh: 4767.
C. behen	1430	Azar: Orumiyeh Gh: 4967.
	1350	Teh: Niavaran Gh: 2375.
	1870	Karaj: Samghabad Gh: 7762.
C. koetana	1410	Lor: Khorramabad, 5Km. to Sepid-dasht Gh: 5477.
Sect. *Paraphysis*		
C. amadanensis var. *amadanensis*	1960	Lor: between Khorramabad & Sepid-dasht Gh: 2177.
C. nenecii		
Sect. *Phalolepis*	2200	Kurd: Saqqez Gh: 5867.
C. aziziana	1100	Maz: Kelardasht Gh: 1176.
Sect. *Psephelloideae*		
C. gilanica	1480	Azar: Orumiyeh Gh: 5067.
	1830	Zanjan: Avaj Gh: 8867.
Sect. *Rhizocalathium*		
C. ustulata	1520	North of Tehran Gh: 1567.
Sect. *Stizolophus*		
C. balsamita subsp. *balsamita*	1320	Ghazvin: 40 Km. to Abhar Gh: 3167.
	1800	Maz: Goolestan Park Gh: 4665.
	1790	Hamadan: 20 Km. to S. Gh: 6567.
C. balsamita subsp. *kermanensis*	2100	Kerman: Mt. Jupar Gh: 9367.
Sect. *Uralepis*		
C. gaubae	1940	Tafresh:15Km. to Saveh Gh:4077.

showed nine bivalents at first metaphase, mostly of rod shape (Fig.3). Chiasma frequency in 16 cells gave a mean of 1.31 per bivalent. According to previous cytological studies, basic number for the section *Cynaroides* is x=9 (Garcia-Jacas & al. 1998).

Section Jacea

C. hyrcanica Bornm.

This taxon is endemic to Iran and Talesh. Two collections of this species were studied (Table 1), material from Firouz-kouh has 2n=22 chromosomes (Fig.4) and specimen from

Mazandaran (Kelardasht) has n=11. On the mitotic metaphase, chromosomes were usually submetacentric which one pair of them has a satellite on short arm. In pollen mother cells eleven bivalents at first metaphase were observed (Fig.5). The mean number of chiasmata per each bivalent was 1.40. This is the first chromosome number report for this taxon. According to literature, the section *Jacea* has basic number x=11, with two races of poloidy (diploidy with 2n=22 and tetraploidy with 2n=44) (Goldblatt 1981-1988).

Section Microlopus

C. polypodiifolia Boiss. var. polypodiifolia

Two collections of this variety were studied, which both have n=8 and 2n=16 chromosomes (Fig. 6). Previous report for this taxon is 2n=16 (see Fedorov 1974).

C. behen L.

Previous reports for this taxon are 2n=26, 2n=36+0-3B (see Fedorov 1974) and n=18 Ghaffari(1989). Our result in this paper is different with previous counts. Three collections of this species were studied (Table 1). They all had n=16 and 2n=32 chromosomes with 0-2B chromosomes. In some cells combination of bivalents and tetravalents at first metaphase were observed (Fig.7). My previous erroneous result (Ghaffari,1989) was due to presence of B-chromosomes and error in counting of chromosomes in multivalents. It should be pointed out, that the previous counts for this taxon are questionable , because all the other counts of section *Microlophus*, showing the basic number x=8. This is the new count for this taxon, which agrees with basic number of section *Microlopus*.

C. koeiana Bornm.

This species is endemic to Iran and Iraq. Meiosis in this species was regular and showed 8 bivalents at first metaphase, which more of them were in ring form (Fig.8). Mean chiasma frequency/bivalent was 1.83. Occasionally in some cells quadrivalent at first metaphase were observed. This is the first chromosome number report for this taxon.

Section Paraphysis

Centaurea amadanensis Schultz-Bip. var. amadanensis

C. amadanensis has two varieties, which both are endemic to Iran (var. *amadanensis* and var. *gymnoclada*). Previous report for *C.amadanensis* is 2n=2x=18 (Garcia-Jacas & *al.* 1998). We studied chromosome behaviour on var. *amadanensis*. Meiosis in this variety was regular with nine bivalents at first metaphase and diakinesis. Chromosome segregation at Anaphase I was (9-9). Occasionally in rare cases, tetravalent at first metaphase were observed (Fig.9). Chiasma frequency in 30 cells gave a mean of 1.27 per bivalent. This is the first chromosome number report for this variety.

Centaurea nemecii Nab.

Previous report for this taxon is 2n=18 (Garcia-Jacas & *al.* 1998). The karyotype in this species consisted of nine chromosome pairs, which were predominantly submetacentric. Two of submetacentric chromosomes have clear satellite in short arm. Meiotic studies in pollen mother cells showed nine bivalents at diakinesis (Fig.10) and first metaphase, which more of them were in rod shape (similar to *C. amadanensis*). The mean number of chiasmata per each bivalent was 1.20.

Section Phalolepis

According to literature many species of this section are distributed in the Greece and Turkey, but two occurs in Flora Iranica (Wagenitz 1980; Georgiadis & *al.*),1996 *C. foreolata*, which is endemic to Iraq and *C. aziziana*, which is endemic to Iran.

C. aziziana is a diploid species with nine bivalents at first metaphase and diakinesis (Fig.11). Previous report for this taxon is 2n=18 Garcia-Jacas & *al.* (1998). According to previous cytological studies, basic number for the section is x=9 Georgiadis & *al.* (1996).

Section Psephelloideae

C. gilanica Bornm.

This species is endemic to Iran. Two collections of this species were studied, which both had 2n=6x=60 (Fig.12). This is the first count for this taxon.

Section Rhizocalathium

C. ustulata DC.

This species is endemic to Iran. Previous report for this taxon is n=9 (Ghaffari 1988). We found 2n=18 chromosomes in metaphase of mitosis. Meiosis in this species was regular with nine bivalents at first metaphase and diakinesis (Fig.13). The mean chiasma frequency was about 1.28 per bivalent. Chromosome segregation at first and second anaphase was (8-8). According to previous cytological studies, basic number for this section is x=9.

Section Stizolophus

Two species of this section occurs in flora of Iran: *C. coronopifolia*, which has a distribution in Iran, Cucasia and Turkey with 2n=26 (Garcia-Jacas *et al.* 1997) and *C. balsamita*.

C. balsamita has two subspecies: *Centaurea balsamita* subsp. *balsamita* and *Centaurea balsamita* subsp. *kermanensis*. *Centaurea balsamita* subsp. *balsamita* occurs in Iran, Turkmanian, Afghanistan and Iraq. Meiosis in this subspecies was regular with 13 bivalents at diakinesis (Fig.14) and first metaphase, which more of them were in rod shape. Zkaukova (see Fedorov, 1974) reported 2n=36 chromosomes for this subspecies.This count is questionable for us, because we examined four collections of this subspecies, which all had n=13 and 2n=26 chromosomes as given in previous report Tonjan (1968). Karyotype in this subspecies was symmetric with predominant submetacentric chromosomes (Fig. 15).

Centaurea balsamita subsp. *kermanensis* is endemic to Iran with 2n=26 chromosomes. The karyotype in this subspecies was similar with subspecies *balsamita* in size and position of centromer (Fig. 16). This is the first chromosome number report for this subspecies.

Section Uralepis

C. gaubae (Bornm.) Wagenitz

The section *Uralepis* in Iran limited to only one species (*C. gaubae*), which is endemic. Meiosis in this species was regular with 14 bivalents at first metaphase. In diakinesis, three bivalents of chromosomes were associated with nucleolus (Fig. 17). The mean number of chiasmata was estimated 1.60 for each bivalent at Metaphase I. This is the first chromosome number report for this species. The basic number for section is x=7.

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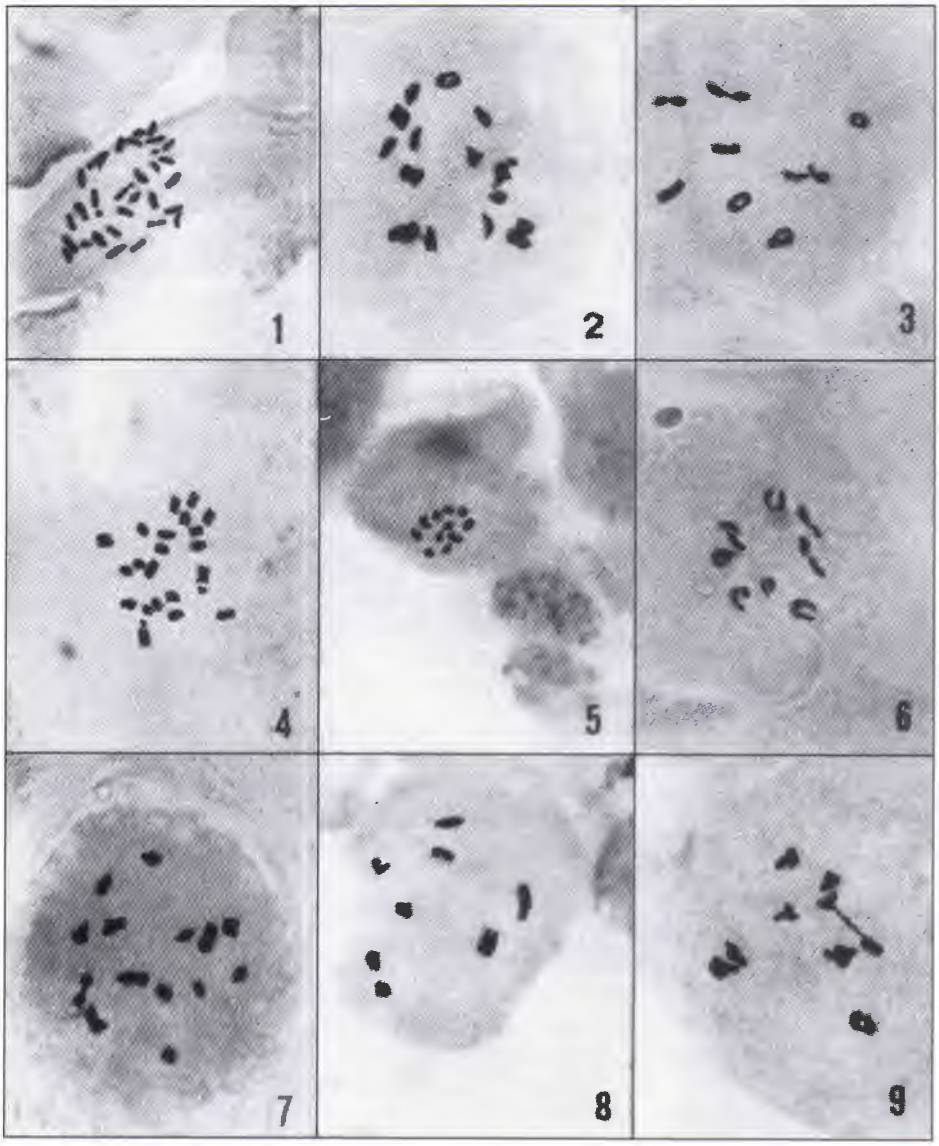
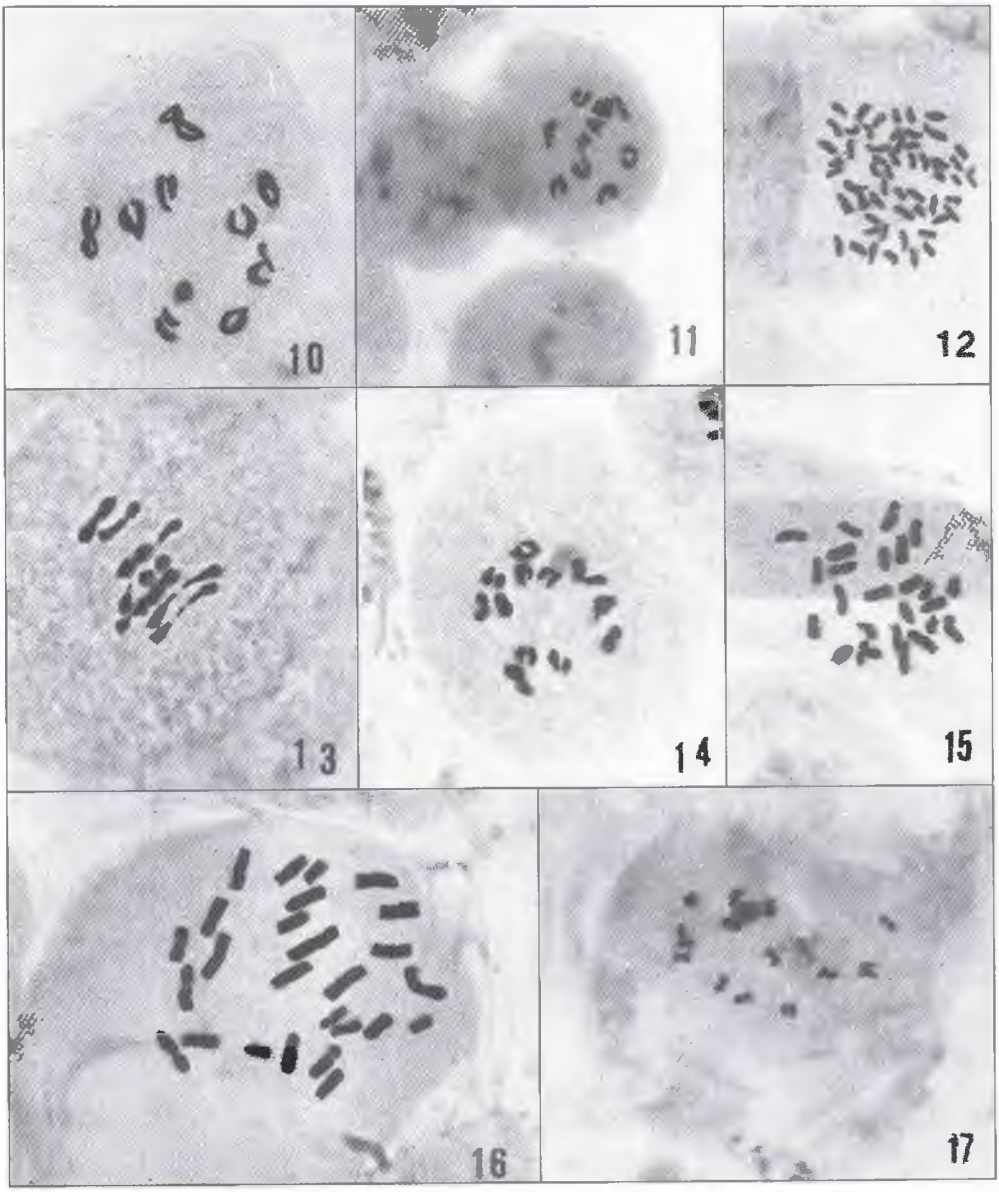


Figures 1-9. Fig. 1. *Centaurea ruthenica,* somatic metaphase (2n=30). Fig. 2. *C pterocaula* subsp. *iranica*, Metaphase I (n=18). Fig. 3. *C imperialis*, Metaphase I (n=9). Fig. 4. *C. hyrcanica*, somatic metaphase (2n=22). Fig. 5. *C. hyrcanica*, Metaphase I (n=11). Fig. 6. *C. polypodiifolia* var. *polypodiifolia,* diakinesis (n=8). Fig. 7. *C behen*, Metaphase I, showing 12 bivalents and 2 tetravalents. Fig. 8 *C. koeiana*, Metaphase I (n=8). Fig. 9. *C. amadanensis* var. *amadanensis*, Metaphase I , showing 7 bivalents and one tetravalent. (magnification for somatic metaphase: 2000x and for meiosis figures:1320x).



Figures 10-17. Fig. 10. *Centaurea. nemecii*, diakinesis (n=9). Fig. 11. *C. aziziana*, diakinesis (n=9). Fig. 12 *C. gilanica*, somatic metaphase (2n=60). Fig. 13. *C.ustulata*. Metaphase I (n=8). Fig.14. *C. balsamita* subsp. *balsamita*, diakinesis (n=13). Fig. 15. *C. balsamita* subsp. *balsamita*, somatic metaphase (2n=26). Fig. 16. *C. balsamita* subsp. *kermanensis*, somatic metaphase (2n=26). Fig. 17. *C.gaubae*, diakinesis (n=14). (magnification for meiosis figures: 1320x. Fig. 12: 2000x and figures 15 and 16: 4000x).

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