CHROMOSOME STUDIES IN SOME SPECIES OF BORAGINACEAE FROM IRAN

S. M. Ghaffari

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Original chromosome observations of 30 populatoins representing 26 species are reported, six of them for the first time. Meiotic behaviour are noted in some species.

Seyyed Mahmood Ghaffari, Institute of Biochemistry and Biophysics, University of Tehran, P.O.Box 13145-1384, Tehran, Iran.

مطالعات کروموزومی روی بعضی گونه‌های خانواده *Boraginaceae* از ایران

سیدمحمود غفّاری

مشاهدات کروموزومی ۳۰ جمعیت متعلق به ۲۶ گونه گزارش می‌شود. شش گونه از گونه‌های مذکور برای اولین بار شمارش کروموزومی شده‌اند. همچنین رفتار کروموزومی در تقسیم میوز تعدادی از گونه‌ها موردتوجه قرار گرفته‌است.

Introduction

Members of the *Boraginaceae* family are distributed in various regions of the world. Although, 289 species belonging to 40 genera are reported in Flora Iranica (Riedl 1967), but it seems that the real number to be more.

The *Boraginaceae* is a highly complex family with a wide range of chromosome numbers (2n=8, 10, 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 34, 36, 38, 40, 42, 44, 48, 50, 52, 56, 64, 66, 70, 72, 84, 88, 100, 108, 120 and 144). Fedorov (1974), Ornduff (1967, 1968), Moore R. J. (1973, 1977), Moore D. M. (1982) and Goldblatt (1981-1994).

The lowest chromosome number belongs to the species *Amsinckia lunaris* Macbr, 2n=8, and the highest to *Symphytum tuberosum* L., 2n=144 (Jaarsma & al. 1990). Although, a lot of papers have been published on the number of chromosomes in this family, but this kind of study on the flora of Iran is limited. In this paper chromosome studies for 30 populations including 26 species in 15 genera are reported. Voucher specimens are preserved in the Central Herbarium of Tehran University (TUH).

Materials and Methods

Floret buds of materials (table 1) were collected and immediately fixed in the field in the Piennar's fixing fluid (ethanol 96%; chloroform; propionic acid; 6: 3: 2 V/V). Anthers were squashed and stained in Fe-acetocarmine. Chromosome counts were carried out from the meiotic microsporocytes which were prepared as mentioned above. All slides were made permanent by the ventian turpentien (Wilson 1945). Photographs of chromosomes were taken on a Wild photomicroscope at initial magnificaiton of 400 x.

Observation and discussion

The results of this study are summerised in table 2, but each species will be dealt with in detail.

Alkanna bracteosa Boiss.; n=14; Fig. 1.

This species is distributed in Iran and Iraq. The small and aggregated chromosomes render difficulties of their count in metaphase. It is probable that the haploid chromosomes to be n=14. This is the first chromosome number report for this taxon. In the literature (Goldblatt 1981-1994) 2n=14, 20, 22, 28 and 30 have been

Tabel 1. The origin of material used in chromosome studies (Gh.=Ghaffari).

Taxon	Origin and colletor
Alkanna bracteosa Boiss.	Tehran: Ab-Ali Gh. 6366.
Anchusa iranica Rech. f. & Esfand.	Karaj: Valian, Gh. 14563.
Anchusa italica Retz.	Karaj: Kushk-Zar, Gh. 2663.
Anchusa italica Retz.	Karaj: Shahdast, Gh. 4563.
Anchusa italica Retz.	Tehran: Sorkh-Hesar, Gh. 4166.
Anchusa italica Retz.	Khuzistan: Dezful, Gh. 366.
Arnebia decumbens (Vent.) Coss. & Kral.	Daylam: 20 km to Omidiyeh, Gh. 967.
Caccinia macranthera (Banks & Soland.)Brand.	Zanjan: Avaj, Gh. 2067.
Caccinia strigosa Boiss.	Tehran: Larijan, Gh. 8964.
Echium amoenum Fisch. & C. A. Mey.	Mazandaran: Chalus, Gh. 1665.
Echium italicum L.	Karaj: Kushk-Zar, Gh. 6562.
Heliotropium chorassanicum Bge.	Khorassan: Robat-Sefid, Gh. 5465.
Heliotropium ellipticum Ledeb.	Azarbaijan: Khalkhal, Akhani 13166.
Heliotropium ramosissimum (Lehm.) DC.	Between Ahvaz & Dezful, Gh. 465.
Heliotropium samoliflorum Bge.	Zanjan: Khamseh, Akhani 13266.
Heliotropium suaveolens M. B.	Ilam: N.E. Mehran, Akhani 13366.
Heterocaryum macrocarpum Zak.	Karaj: Shahdast, Gh. 262.
Lappula microcarpa (Boiss.) H. Riedl	Tehran: Ab-Ali, Gh. 13764.
Moltkia coerulea (Willd.) Lehm.	Zanjan: Avaj, Gh. 1967.
Nonnea caspica (Willd.) G. Don.	Karaj: Shahdasth, Gh. 6363.
Nonnea persica Boiss.	Eshtehard: Dakin, Gh. 4766.
Nonnea pulla (L.) DC.	Khuzistan: Dezful, Gh. 1564.
Onosma longilobum Bge.	Between Qom & Tehran, Gh. 2665.
Onosma microcarpum DC.	Tehran: Soleghoon, Gh. 5366.
Onosma sericeum Willd.	Tehran: Ab-Ali, Gh. 6566.
Onosma sericeum Willd.	Tehran: Sorkh-Hesar, Gh. 3066.
Paracaryum rugulosum (DC.) Boiss.	Between Shahroud & Sabzevar, Gh. 8566.
Rindera albida (Wettst.) Kusn.	Tehran: Sorkh-Hesar, Gh. 3366.
Solenanthus stamineus (Desf.) Wettst.	Karaj: Kandavan, Gh. 13263.
Trichodesma incanum (Bge.) DC.	Karaj: Asara, Gh. 15964.

reported for the genus *Alkanna*. It seems three basic number (X=7, 10, 11) are present in this genus, but the origin of basic number is not clear at present.

Anchusa iranica Rech. f. & Esfand.; n=8; Fig. 2, 3.

This speices is endemic to Iran. Meiosis was shown to be regular forming eight bivalents at first metaphase. There was usually terminal and interstitial chiasmata in each bivalent. The chromosome segregation in anaphase one was normal formed to (8-8). One pair of chromosomes included nuclear organization region (NOR).

Anchusa italica Retz.; n=16; Fig. 4-9.

According to table (1) four populations of this species were studied. In the sample from Tehran 16 bivalents usually in the form of rings were observed. Occasionally in some cells non-disjunct chromosomes in anaphase one to form (15-17), and phenomen of heterozygous for a paracentric inversion in second anaphase were observed. The inversion produced dicentric chromatid bridges, and fragments. The samples from Karaj were normal forming 16 bivalents at metaphase one. Sample of Dezful was irregular. In metaphase one fragments, univalents, bivalents and polyvalents in the form of chain or ring were observed. The polyvalents may be organized by consecutive translocation between non-homologous chromosomes. In some cells laggard chromosomes non-disjunction at first anaphase were observed. Meiotic studies for this species is reported for the first time.

Arnebia decumbens (Vent.) Coss. & Kral.; n=11; Fig. 10.

Previous reports for this taxon are 2n=8 (Fedorov 1969) and n=11 (Aryavand 1975). We observed 11 bivalents at first metaphase.

Caccinia macranthera (Banks & Soland.) Brand; n=12; Fig. 11.

The *Caccinia* genus typically belongs to the Irnao-Turanian reiogn. There are four species in Flora Iranica which 3 of them are endemic of Iran. The gametic number of chromosomes for *C. macranthera* was n=12. This is the first chromosome number report.

Caccinia strigosa Boiss.; n=12; Fig. 12, 13.

This species is endemic to Iran. The chromosome complement, (2n=24) were observed in prophase cells at mitotic division and haploid chromosomes were observed at metaphase one in meiosis.

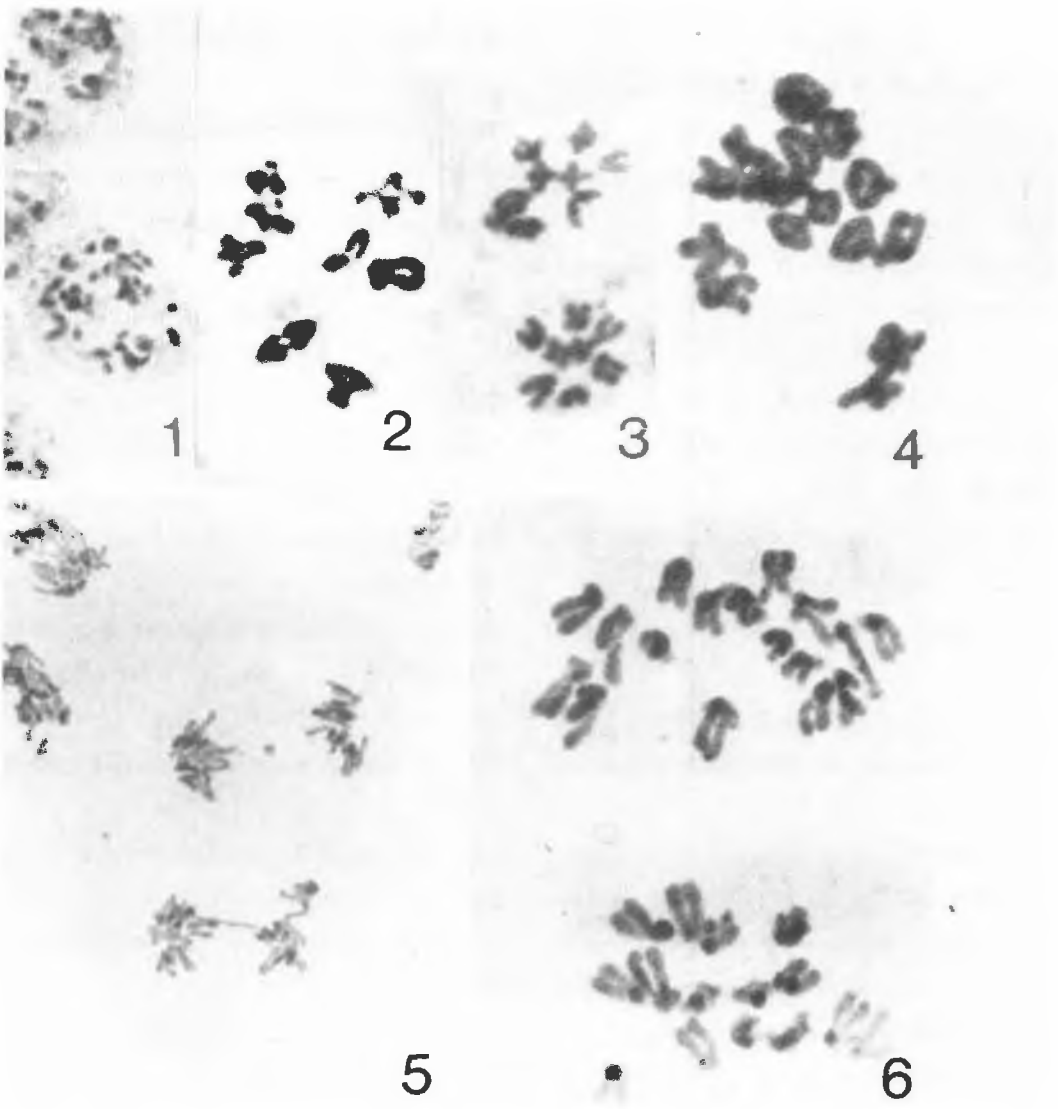

Fig. 1-6. Meiosis. -1. *Alkanna bracteosa*, diakinesis, n=14. -2,3. *Anchusa iranica,* diakinesis and anaphase I, n=8. -4-6. *Anchusa italica*: 4. metaphase I, n=8 (sample of Karaj). 5. anaphase II, showing bridge and fragment (sample of Tehran). 6. anaphase I showing (15-17) segregation (sample of Tehran).

Therefore, the basic chromosome number for this genus is x=12.

Echium amoenum Fisch. & C. A. Mey.;n=8; Fig. 14.

The gametic chromosome number for this taxon was n=12. The bivalents at first metaphase were ususally in the form of rod.

Echium italicum L.; n=8; Fig. 15.

Previous reports 2n=16 and 2n=32 indicate that this species has both dipliod and tetraploid races. Tetraploid race only reported from Spain by Gadella (1966). The sample of this study was diploid with 8 bivalents in metaphase one.

Heliotropium chorassanicum Bge.; n=8; Fig. 16.

Heliotropium is a highly complex genus with a wide range of chromosome numbers (2n=14, 16, 18, 22, 24, 26, 28, 32, 42, 38, 50, 52, 64).

There are 74 species in Flora Iranica (Riedl 1967), 39 of which endemic to Iran. *H. chorassanicum* is distributed in N.E. of Iran, Turkmenistan and Afghanistan. Haploid chromosome (n=8) in diakinesis and anaphase one were counted.

Heliotropium ellipticum Ledeb.; n=8.

Meiosis in this species was shown to be regular forming 8 bivalents at diakinesis. This is the first chromosome number report for this taxon.

Heliotropium ramosissimum (Lehm.) DC.; n=16; Fig. 17.

This species was tetraploid and 16 bivalents were observed at first metapahse.

Heliotropium samoliflorum Bge.; n=8; Fig. 18.

The species is endemic to Iran and this is the first chromosome number report for it. 8 bivalents were observed in the first metaphase which formed mostly rod.

Heliotropium suaveolens M. B.; n=16.

Murin & Sheikh (1971) reported 2n=48 chromosomes for this taxon from Iraq. But the sample of this investigation was n=16, therefore this species has both hexaploid and tetreploid races.

Heterocaryum macrocarpum Zak.; n=24; Fig. 19.

Previous report for this taxon was 2n=48 (Podlech & Dieterle 1969).

Lappula microcarpa (Boiss.) H. Riedl; n=12; Fig. 20.

This species was diploid and had n=12 chromosomes at meiosis.

Moltkia coerulea (Willd.) Lehm.; n=14; Fig. 21.

Fourteen bivalents were observed in diakinesis. This is the first chromosome number report for this taxon.

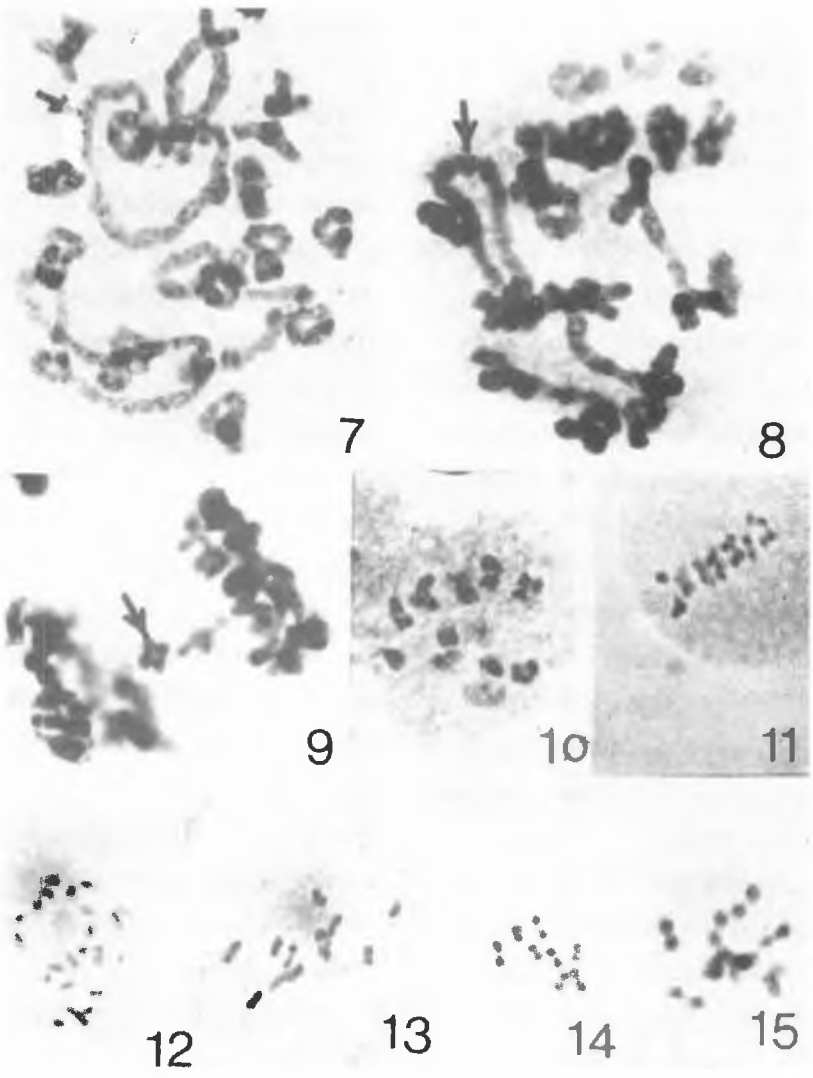

Fig. 7-15. Meiosis and mitosis. -7-9. *Anchusa italica* n=16 (sample of Dezful): 7 and 8 metaphase I showing ring multivalent and chain. 9. anaphase I showing laggard chromosome. -10. *Arnebia decumbens*, diakinesis, n=11. -11. *Caccinia macranthera*, meiosis metaphase I, n=12. -12. *C. strigosa*, mitosis prophase, 2n=24. -13. *C. strigosa*, meiosis metaphase I, n=12. -14. *Echium amoenum*, metaphase I, n=8. -15. *E. italicum,* diakinesis, n=8.

Nonnea caspica (Willd.) G. Don.; n=14; Fig. 22.

Meiosis in this speices was shown to be regular forming fourteen bivalents at first metaphase. Previous reports for this taxon are n=22 and 2n=44 by Aryavand (1975), n=16 by Vasudevan (1975) and 2n=28 Podlech & Bader (1974).

Nonnea persica Boiss.; n=16; Fig. 23, 24.

This species is endemic to Iran. In both diakinesis and first metaphase 16 bivalents were observed. Occasionally at metaphase two, laggard chromosomes were observed.

Nonnea pulla (L.) DC.; n=22; Fig. 25.

Previous reports for this taxon are 2n=14, 20, 28 and 44 (Goldblatt 1981-1984). I found 22 bivalents at first metaphase. It seems that polyploidy and dysploidy have an important role in chromosome number variation in this species.

Onosma longilobum Bge. ; n=8; fig. 26, 27.

59 species of *Onosma* distributed in Flora Iranica area in which 39 of them are endemic to the area. The range of chromosome number in this genus are (2n=12, 14, 16, 18, 21, 22, 24, 27, 38 and 50) Fedorov (1974), Ornduff (1967, 1968), Moore (1973, 1977), Goldblatt (1981-1994).

O. longilobum is endemic to Iran and Turkmenia. This species is a diploid and has 8 bivalents in meiosis. Two laggard chromosomes at metaphase two were observed.

Onosma microcarpum DC.; n=8; Fig. 28.

This species is a diploid, and haploid chromosome number for it is n=8.

Onosma sericeum Willd; n=16; Fig. 29.

Two samples of this species have been studied, and both have n=16 chromosomes. Previous reports for thid taxon are 2n=12 and 16.

Paracaryum rugulosum (DC.) Boiss.; n=12; Fig. 30.

Rindera albida (Wettst.) Kusn.; n=12; Fig. 31, 32.

This species is endemic to Iran. There are at present time two chromosome number reports for the genus; *R. albida* (in this paper) n=12 and *R. graeca*, 2n=24 Gustavsson (1978). The basic chromosome number for this genus is x=12.

Solenanthus stamineus (Desf.) Wettst; n=12; Fig. 33.

Trichodesma incanum (Bge.) DC.; n=12; Fig. 34.

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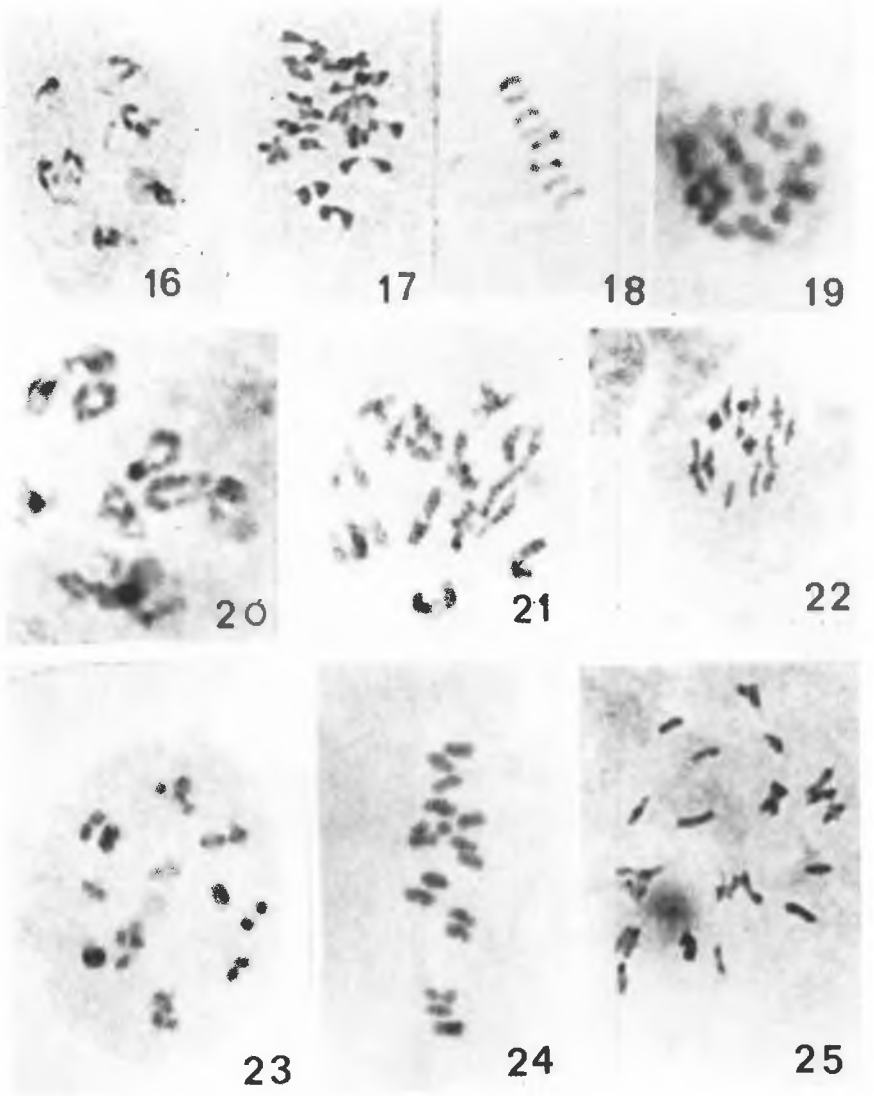

Fig. 16-25 Meiosis. -16. *Heliotropium chorassanicum*, diakinesis, n=8. -17. *H. ramosissimum*, metaphase I, n=16. -18. *H. samoliflorum*, metaphase I, n=8. -19. *Heterocaryum macrocarpum*, metaphase II (one pole of cell), n=24. -20. *Lappula microcarpa*, diakinesis, n=12. -21: *Moltkia coerulea*, diakinesis, n=14. -22. *Nonnea caspica*, metaphase I, n=14. -23, 24. *N. persica*, diakinesis and metaphase I, n=16. -25. *N. pulla*, metaphase I, n=22.

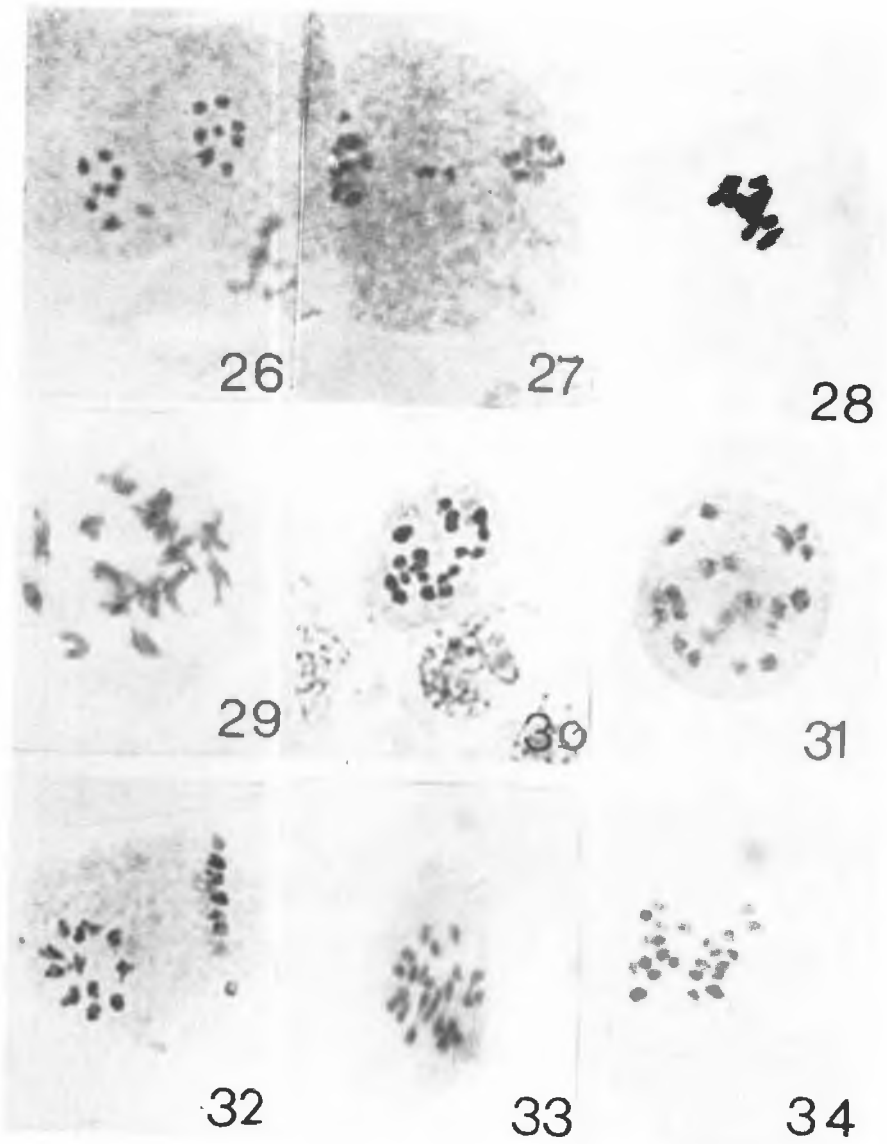

Fig. 26-34. Meiosis. -26, 27 *Onosma longilobum*, anaphase I (8-8) and metaphse II (showing two laggard chromosomes), n=8. -28. *O. microcarpum*, metaphase I, n=8. -29. *O. sericeum*, diakinesis, n=16. -30. *Paracaryum rugulosum*, metaphase I, n=12. -31, 32. *Rindera albida*, diakinesis and metaphase II, n=12. -33. *Solenanthus stamineus*, metaphase I, n=12. -34. *Trichodesma incanum*, anaphase I (12-12), n=12.

Tabel 2. Chromosome counts in *Boraginaceae.*

Taxon	Present count		Previous counts			Level of ploidy
	n	2n	n	2n		
Alkanna bracteosa	14	-	-	-		Tetraploid
Anchusa iranica	8	-	8	-	Ghaffari 1987	Diploid
A. italica	16	-	-	32	D'Amato & Trojani 1985	Tetraploid
Arnebia decumbens	11	-	11	-	Aryavand 1975	Diploid
Caccinia macrantera	12	-	-	-		Diploid
Caccinia strigosa	12	24	12	-	Ghaffari 1986 b	Diploid
Echium amoenum	8	-	8	-	Ghaffari 1987	Diploid
Echinum italicum	8	-	8	16	Aryavand 1977, Cardona 1973	Diploid
				32	Gadella & Kliphuis 1966	Tetraploid
Heliotropium chorassanicum	8	-	8	-	Ghaffari 1988	Diploid
H. ellipticum	8	-	-	-		Diploid
H. ramosissimum	16	-	16	-	Ghafffari 1987	Tetraploid
H. samoliflorum	8	-	-	-		Diploid
H. suaveolens	16	-	-	48	Murin & Scheikh 1971	Diploid
Heterocaryum macrocarpum	24	-	12	48	Podlech & Dieterle 1969, Ghaffari 1988	Tetraploid
Lappula microcapa	12	-	12	-	Ghaffari 1986 a	Diploid
Moltkia coerulea	14	-	-	-		Diploid
Nonnea caspica	14	-	16	28	Vasudeva 1975,Podlech & Bader 1974	Tetraploid
N. persica	16	-	16	-	Ghaffari 1988	Tetraploid
N. pulla	22	-	10	20	Füernkranz 1967	Tetraploid
Onosma longilobum	8	-	8	-	Ghaffari 1988	Diploid
O. microcapum	8	-	8	16	Ghaffari 1988, Popova & al. 1985	Diploid
O. sericeum	16	-	-	16	Teppner 1974	Tetraploid
Paracaryum rugulosum	12	-	12	-	Ghffari 1988	Diploid
Rindera albida	12	-	12	-	Ghffari 1988	Diploid
Solenanthus stamineous	12	-	12	-	Ghffari 1986 b	Diploid
Trichodesma incanum	12	-	12	-	Ghffari 1986 b	Diploid

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