CHROMOSOME STUDIES IN THE IRANIAN ASTERACEAE II

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Ghaffari, S. M. 1999 08 01: Chromosome studies in the Iranian *Asteraceae* II. *-Iran. Journ. Bot. 8 (1): 91-104.* Tehran.

This is the second report of chromosome studies from the Iranian *Asteraceae*. In the present study 28 populations representing 25 species are reported. Chromosome studies of eleven species are new and one species (*Carduus seminudus*) differring from the previous report. Also, chromosome basic number for the genus *Grantia* is reported for the first time. Counts for eight additional taxa are the first reports for flora of Iran. Meiotic behavior are noted in some species.

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Keywords. Asteraceae, chromosomes, Iran.

مطالعات کروموزومی روی خانواده Asteraceae در ایران (۲)

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این دومین بخش از مجموعه مطالعات کروموزومی روی گیاهان خانواده *Asteraceae* ایران است. در مطالعه حاضر ۲۸ جمعیت متعلق به ۲۵ گونه گزارش شده است. شرح مطالعات کروموزومی ۱۱ گونه جدید است و گزارش کروموزومی گونه *Carduus seminudus* با گزارش قبلی تفاوت دارد. همچنین عدد پایه کروموزومی جنس *Grantia* برای اولین بار گزارش می‌شود. شمارش کروموزومی ۸ گونه دیگر برای فلور ایران جدید است. رفتار کروموزومی در تقسیم میوز برای تعدادی از گونه‌ها یادداشت شده است.

INTRODUCTION

The value of chromosome studies (numbers and behaviour) to improve taxonomic understanding of many groups of seed plants has been cited repeatedly (Heywod & Moore 1984), (Greilhuber & Ehrendorfer 1988). Particulary in recent years there have been numerous papers reporting chromosome counts for miscellaneous *Asteraceae*. *Asteraceae* is the largest family of Angiosperms in the flora of Iran with about 1123 species (Ghahraman 1999). But in Iran only 148 species representing 50 genera have hitherto been subjected to cytological studies (Ghaffari unpublished). However, the numerous species being cytologically investigated. In the previous study (Ghaffari 1984) 28 species representing 16 genera of family *Asteraceae* were reported. In this paper chromosome studies for 28 populations including 25 species in 23 genera are reported.

I have indicated not only collection data and number of chromosomes, but also notes on meiotic behaviour and for plants in which meiosis was found to be irregular.

MATERIAL AND METHODS

Floret buds of materials (Table 1) were collected and immediately fixed in the Piennar's fixing fluid (ethanol 96%, chloroform, propionic acid, 6:3:2 V/V). Anthers were squashed and stained with 2% acetocarmine. All slides were made permanent by the ventian turpentien (Wilson 1945). Photographs of chromosomes were taken on an Olympus photomicroscope at initial magnification of 330X. Voucher specimens are preserved in the Central Herbarium of Tehran University (TUH).

RESULT AND DISCUSSION

1. Achillea millefolium L. subsp. millefolium; n=36 II+0-3B (Fig. 1).

Previous reports for this taxon are 2n=18, 36, 36+B, 45+B and 72 (Ehrendorfer 1960, Gupta & Gill 1989, Lavrenko & Serditov 1991, Dabrowska 1992). This species has diploid, tetraploid, and hexaploid races. The recent report for this taxon is 2n=81± 5 (Murin 1997). Murin believed that in common hexaploid populations with 2n=54, some individulas might appear as a result of fertilization between reduced (2n=27) and unreduced (2n=54) gamets giving rise to nonaploid (2n=81). Our sample was octaploid with 2n=72 chromosomes. Meiosis in this subspecies

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

Taxon	Orogin and Collector
Achillea millefolium L. subsp. *millefolium*	Mazandaran: Kandavan Mt., Gh. 2576.
Anthemis odontostephana Boiss. var. *tubicina* (Boiss.& Hausskn.) Bornm.	Tehran: Sorkh-e-Hesar, Gh. 971.
Calendula persica C. A. Mey.	Khorramabad: 7 km. S. Gh. 871.
Calendula persica C. A. Mey.	Dezful: around Dez river, Gh. 171.
Calendula persica C. A. Mey.	Dezful: Safiabad, Gh. 1064.
Carduus seminudus M. B.	Chalus: Marzanabad, Gh. 2165.
Cirsium alatum (S. G. Gmelin) Bobrov	Azerbaijan: Mahabad, Gh. 970.
Cirsium arvense (L.) Scop.	Azerbaijan: Maragheh, Gh. 18171.
Codonocephalum peacockianum Aitch. & Hemsl.	Azerbaijan: Between Mianeh & Bostanabad, Gh 3967.
Echinops ritrodes Bunge	Azerbaijan: Between Khoy & Salmas, Gh. 18571.
Grantia arachnoidea Boiss.	Between Genaveh & Daylam, Gh. 767.
Lactuca scariola L.	Karaj: Taleghan, Minavand, Gh. 8762.
Lapsana communis L.	Karaj: Gachsar, Gh. 1596.
Launaea mucronata (Forssk) Muschl.	Between Daylam & Genaveh, Gh. 975.
Leontodon asperrimus (Willd.) Ball	Karaj: Dizin, Gh. 1473.
Liguralia persica Boiss.	7 km E. of Chalus., Gh. 2876.
Oligochaeta divaricata (Fisch & Mey.) Koch	Between Zanjan & Mianeh, Gh. 3467.
Phagnalon rupestre (L.) DC.	Dezful, Gh. 965.
Scleorhachis leptoclada Rech. f.	Between Semnan & Damghan, Gh. 9166.
Scorzonera ramosissima DC.	Eshtehard: Dakin, Gh. 4366.
Senecio mollis Willd.	Azerbaijan: Mahabad, Gh. 870.
Senecio pseudo-orientalis Schischk.	Azerbaijan: Mahabad, Gh. 770.
Taraxacum calliops Hagl.	5 Km S. of Karaj, Gh. 663.
Tragopogon pterocarpus DC.	Karaj: Dehak, Gh. 1975.
Tripleurospermum disciforme (Mey.) Schultz - Bip.	Between Mashhad & Ghochan, Gh. 5741.
Urospermum picroides (L.) Desf.	Khuzistan: Ahwas, Gh. 3264.
Zoegea leptaurea L. subsp. *mianensis* (Boiss.) Rech. f.	Between Zanjan & Mianeh, Gh. 16371.
Zoegea leptaurea L. subsp. *mianensis* (Boiss.) Rech. f.	Between Bookan & Saqqez, Gh. 5567.

was regular and showed 36 bivalents at diakinesis. Occasionally in some cells 0-3 B-chromosomes were observed. This is the first chromosome number report for flora of Iran.

2. Anthemis odontostephana Boiss. var. **tubicina** (Boiss. & Hausskn.) Bornm.; n=9 (Fig. 2).

Two varieties of this species are presented in flora of Iran (Iranshahr 1986): var *odontostophana* which has to be cytologically investigated and var *tubicina* which is surveyed here. According to literature the genus *Anthemis* has chromosome basic number X=9, with three races of poloidy (diploidy with 2n=18, tetraploidy with 2n=36, and hexaploidy with 2n=54). Frequency of diploid species are more than the others. A rare case of aneuploidy is reported by Kuzmanov & al. (1981). This variety is diploid with nine bivalents which observed at first metaphase and diakinesis. Most of the bivalents have two terminal chiasmata. This is the first chromosome number report for this variety.

3. Calendula persica C. A. Mey.; n=22 II (Figs. 3, 4, 5)

Three collections of this species were studied (Table 1). They all had n=22 chromosomes. Twenty two bivalents were observed at diakinesis, which two of them were associated with nucleolus. This is the first chromosome number count for this species (Ghaffari 1987).

4. Carduus seminudus M. B.; n=16 II (Fig. 6).

This species is distributed in Talesh, Caucasia and Iran. First chromosome number report for this taxon is 2n=28 (Zemskova & Ciklauei 1987) from Caucasia. Meiosis in our sample was regular and showed sixteen bivalents at first metaphase and diakinesis. Chromosome segregation at first anaphase was also (16-16). The genus *Carduus* is a highly complex with a wide range of chromosome numberes (2n=16, 18, 20, 22, 24, 26, 32, 34, 36, 54, 62, 64), Fedorov (1974), Ornduff (1967, 1968), Moore, K. J. (1973, 1977), Moore, D. M. (1982), Goldblatt (1981-1988) and Goldblatt & Johnson (1990-1996). As 2n=28 has not been confirmed again, it should not be correct.

5. Cirsium alatum (S. G. Gmelin) Bobrov; n=17 II (Fig. 7).

I observed 17 paris of chromosomes at first metaphase. This is the first chromosome number report for this taxon.

6. Cirsium arvense (L.) Scop.; n=17 II (Fig. 8).

Privious report for this species is 2n=34, Podlech & Bader (1974), Talavera (1974). One case of tetraploidy level (2n=68) for this taxon was reported by Czapik (1958). This is the first count for flora of Iran.

7. Codonocephalum peacockianum Aitch. & Hemsl.; n=10 II (Fig. 9).

The first report for this taxon is 2n=20, Chouksanova & al. (1968). Two collections of this species were studied (Table 1). They all had n=10 chromosomes. This is the first chromosome number report for the flora of Iran.

8. Echinops ritrodes Bunge; n=16 II (Fig. 10).

This species is endemic to Iran and Turkmenia. Sixteen bivalents were observed at diakinesis. This is the first chromosome number report for this taxon.

9. Grantia arachnoidea Boiss.; n=10 II (Fig. 11).

This species is endemic to Iran, (Lack 1980). Survey of the available literature shows that no previous count has been recorded for this species and other species of the genus *Grantia* in existing chromosome number indexes. The gametic number (n=10) for this species and chromosome basic number (X=10) for the genus *Grantia* is reported for the first time.

10. Lactuca scariola L.; n=9 II (Fig. 12).

Previous reports for this taxon are 2n=18 (Mehra & al. 1965) and n=9 (Gupta & Gill 1989). Nine bivalents with terminal and interstitial chiasmata were observed at diploten. This is the first record of chromosome number for this species in Iran.

11. Lapsana communis L.; n=7 II (Fig. 13).

Previous reports for this taxon are 2n=16 and 14, Kuzmanov (1977), Ghaffari (1989).

12. Launaea mucronata (Forssk.) Muschl.; n=8 II (Fig. 14).

Previous reports for this species are 2n=16 Amin (1973), Ghaffari (1987). Meiosis in this species was regular and showed eight

bivalents at first metaphase. The mean chiasma frequency was about 1.27 per bivalents. Chromosome segregation at first and second anaphase was (8-8).

13. Leontodon asperrimus (Willd.) Ball; n=4 II (Fig. 15).

Previous report for this taxon are 2n=8. Stebbins & al. (1953), Bergman (1935), Nazarova (1984), Ghaffari, (1989). Meiois in this species was regular with four bivalents which mainly were in ring form. Most bivalents had two chiasmata. Chiasma average was calculated 1.91 at first metaphase.

14. Ligularia persica Boiss.; n=30 II (Fig. 16).

This species is endemic to Iran, and the fist chromosome count (2n=60) for this taxon was reported by Zhukova (1967). I observed 30 bivalents with terminal and interstital chiasmata at diakinesis.

15. Oligochaeta divaricata (Fisch. & Mey.) C. Koch; n=12 II (Fig. 17).

Previous report for this species is 2n=24 (Tonjan 1968). Twelve bivalents were observed at diakinesis. This is the new chromosome record for Iran.

16. Phagnalon rupestre (L.) DC.; n=9 II (Fig. 18).

Previous reports for this species are 2n=18, Larsen (1956), Borgen (1970), Oberprieler & Vogt (1993). This is the first chromosome count for the flora of Iran.

17. Sclerorhachis leptoclada Rech. f.; n=9 II (Fig. 19).

This species is endemic to Iran and its chromosome number is reported for first time. Meiosis in this taxon was regular and showed nine bivalents at diakinesis and first metaphase. Chiasma average was calculated 1.46. There are three other species of this genus in the family *Asteraceae* namely *S. polysphaera* Rech. f. and S. *caulescens* (Aitch. & hems.) Rech. f. endemic to Afghanistan and S. *platyrachis* (Boiss.) Podlech (Syn.: *S. rechingeri*) endemic to Iran with n=9 chromosomes (Ghaffari 1984). Thus the basic chsomosome number for the genus is x=9.

18. Scozonera ramosissima DC.; n=6 II (Fig. 20).

This species is diploid with six bivalents at both diakinesis and first metaphase. This is

the first chromosome number report for this taxon.

19. Senecio mollis Willd.; n=20 II (Fig. 21).

I observed 20 bivalents at diakinesis in the forms of rods and a few rings. This is the first chromosome number report for this taxon.

20. Senecio pseudo-orientalis Schischk.; n=20 II (Fig. 22).

This is the first chromosome number report for this taxon.

21. Taraxacum calliops Hagl.; n=12 II (Fig. 23).

Meiosis in this species was irregular with laggard chromosomes in anaphase 1 and II. In telophase II, one or two micronucleulse were observed. This is the first chromosome number report for this taxon.

22. Tragopogon pterocarpus DC.; n=12 II (Fig. 24).

Previous report for this taxon is 2n=12 (Nazarova 1991). Our sample was tetraploid with 12 bivalents at first metaphase. Therefore, this species has both diploid and tetraploid races. This is a new chromosome count for Iran.

23. Tripleurospermum disciforme (C. A. Mey.) Schultz-Bip.; n=9 II, 2n=18 (Fig. 25, 26).

Previous reports for this species are 2n=18 Aryavand (1977), Kay (1969). Mitotic studies in meristematic cells of root tips showed 18 chromosomes, which more of them were acrocentric. Meiotic studies in pollen mother cells confirmed our observation of mitotic studies with a gametic number of n=9.

24. Urospermum picroides (L.) Desf.; n=5 II (Fig. 27).

Previous report for this taxon is 2n=10 Ghaffari (1987), Pastor (1983). Meiosis in this species was regular with 5 bivalents at first metaphase. Chromosome segregation at first anaphase was (5-5).

25. Zoegea leptaurea L. subsp. **mianensis** (Boiss.) Rech. f.; n=14 II (Fig. 28).

Two collections of this subspecies were studied (table 1), which both had n=14 chromosomes. This subspecies is endemic to Iran and its chromosome number is reported for the first time.

ACKNOWLEDGEMENTS

This work was supported by a grant (31303241) from National Research Council and Research Council of University of Tehran. I should like to thank Dr. Iranshahr and V. Mozaffarian for identification of some plants.

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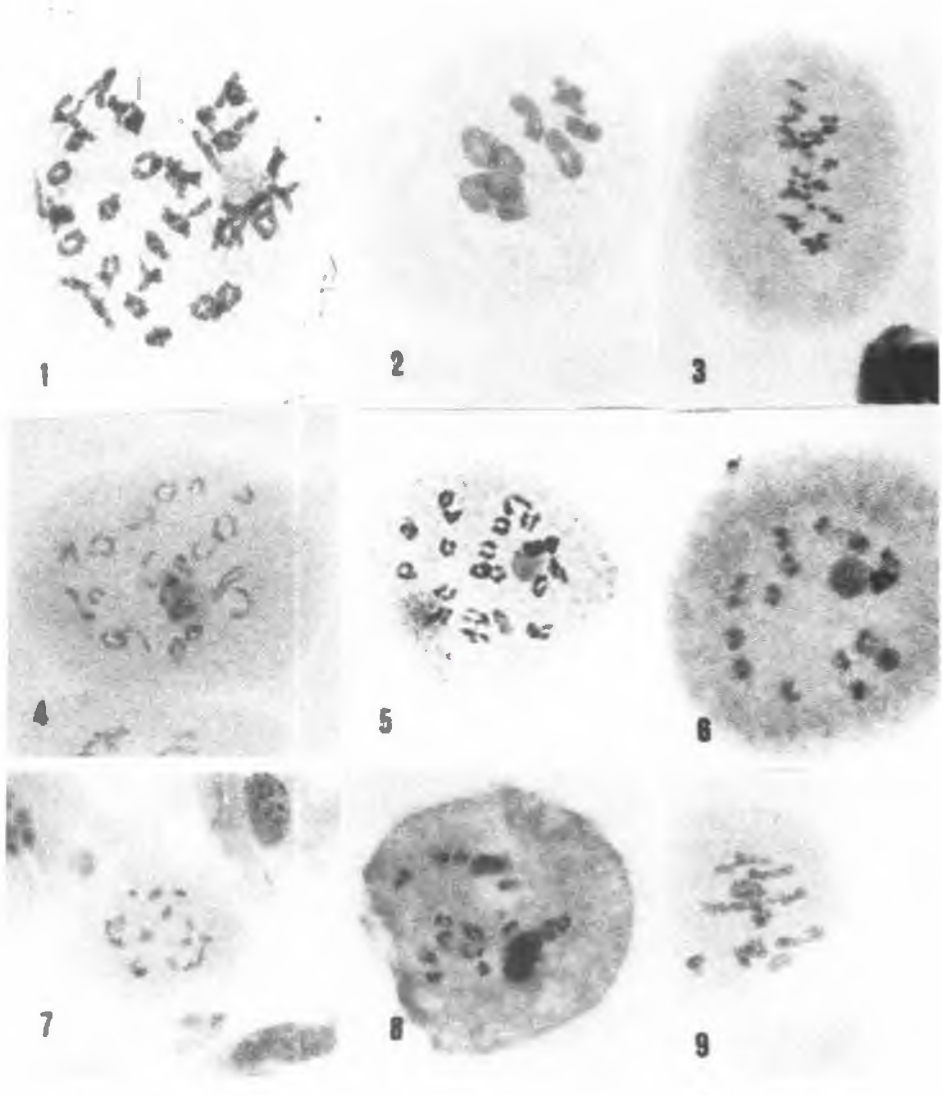

Fig. 1-9. -1: *Achillea millefolium*, diakinesis, n=36. -2: *Anthemis odontostephana* var. *tubicina*, metaphase I, n=9.- 3: *Calendula persica*, metaphase I, n=22, from Khorramabad, -4: *Calendula persica*, diakinesis, n=22, from Dezful around Dez river. -5: *Calendula persica*, diakinesis, n=22, Dezful: Safiabad. -6: *Carduus seminudus*, diakinesis, n=16. -7: *Cirsium alatum*, metaphase I, n=17.- 8: *Cirsium arvense*, diakinesis, n=17. -9: *Codonocephalum peacokianum*, metaphase I, n=10.

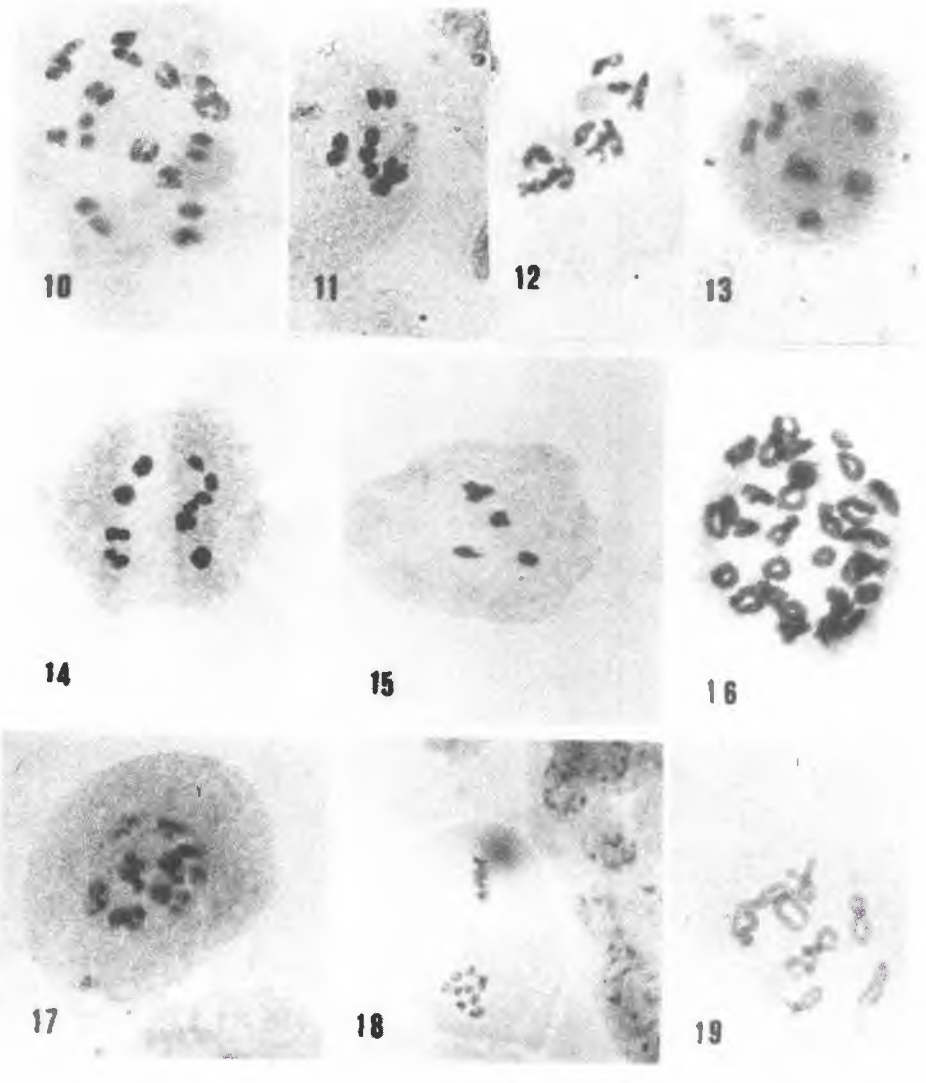

Fig. 10-19. -10: *Echinops ritrodes*, diakinesis, n=16. -11: *Grantia arachnoidea*, metaphase I, n=10. -12: *Lactuca scariola*, diplotene, n=9. -13: *Lapsana communis*, diakinesis, n=7. -14: *Launaea mucronata*, metaphase I, n=8. -15: *Leontodon asperimus*, metaphase I, n=4. -16: *Ligularia persica*, diakinesis, n=30. -17: *Oligochaeta divaricata*, diakinesis, n=12. -18: *Phagnalon rupestre*, metaphase II, n=9. -19: *Sclerorhachis leptoclada*, diplotene, n=9.

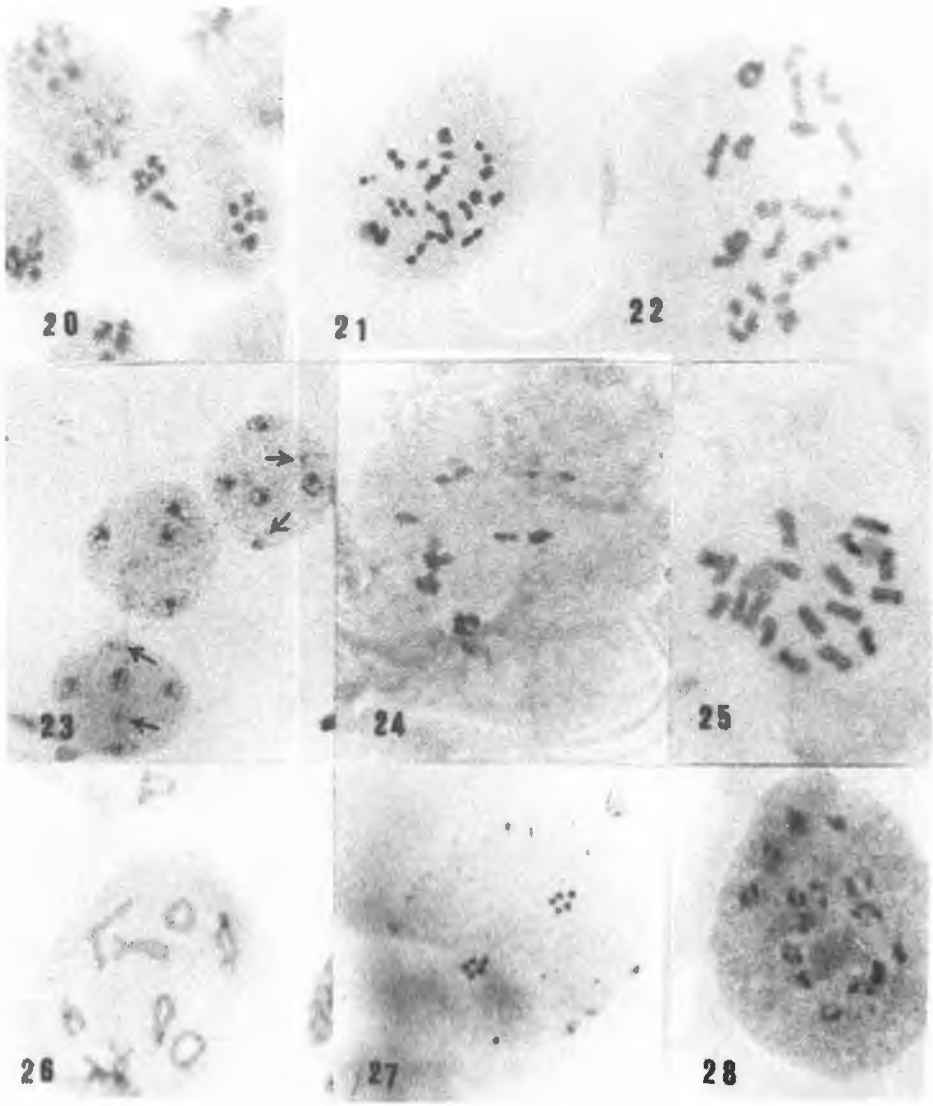

Fig. 20-28. -20: *Scozonera ramosissima*, anaphase I, n=6. -21: *Senecio mollis*, diakinesis, n=20. -22: *Senecio pseudo-orientalis*, metaphase I, n=20. -23: *Taraxacum calliops*, telophase II, showing micronuclei (arrows). -24: *Tragopogon pterocarpus*, metaphase I, n=12. -25: *Tripleurospermum disciforme,* somatic prophase, 2n=18.-26: *Tripleurospesmum disciforme*, diakienesis, n=9. -27: *Urospermum picroides*, anaphase I, n=5. -28: *Zoegea leptaurea*, diakinesis, n=14.