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A cytological study of flowering plants from Saudi Arabia

Abstract

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The chromosome numbers of 31 taxa belonging to 14 families of angiosperms collected from different regions of Saudi Arabia are reported. These include first chromosome number reports for six species: *Anabasis setifera* 2n=18, *Cleome amblyocarpa* 2n=20, *Halopeplis perfoliata* 2n=18, *Lavandula coronopifolia* 2n=42, *Lycium shawii* 2n=24 and *Salvia deserti* 2n=48. A new basic number and/or a new ploidy level is reported for two species: *Asphodelus tenuifolius* 2n=4x=52 and *Heliotropium lasiocarpum* 2n=4x=32. The chromosome numbers of the other 23 species are the first reports from Saudi Arabian populations: *Abrus precatorius* 2n=22, *Alhagi camelorum* 2n=16+2B, *Amaranthus spinosus* 2n=34, *Astragalus abyssinicus* 2n=16, *Bienertia cycloptera* 2n=18, *Capparis spinosa* 2n= 38, *Chenopodium album* 2n=54, *C. ambrosioides* 2n=32, *C. ficifolium* 2n=18, *C. glaucum* 2n=18, *C. murale* 2n=18, *Datura innoxia* 2n=24, *Halocnemum strobilaceum* 2n=18, *Leptadenia pyrotechnica* 2n=22, *Moltkiopsis ciliata* 2n=12, *Rumex dentatus* 2n=40, *Salvia aegyptiaca* 2n=28, *S. spinosa* 2n=20, *Senna alexandrina* 2n=28, *Sesuvium sesuvioides* 2n=16, *Silene apetala* 2n=24, *Withania somnifera* 2n=48 and *Zygophyllum coccineum* 2n=16. Karyotype analyses for six species, viz. *Alhagi camelorum, Astragalus abyssinicus, Datura innoxia, Moltkiopsis ciliata, Sesuvium sesuvioides* and *Rumex dentatus* are presented.

Introduction

Saudi Arabia, the largest country of the Arabian Peninsula, has a diversified higher plant flora in its varied landscapes, with about 2243 species in 837 genera and 142 families (Collenette 1998, 1999). Al-Farhan (1999) recognizes three phytogeographical regions in Saudi Arabia, namely (i) the Saharo-Sindian region, (ii) the Somali-Masai region and (iii) the Afro-montane archipelago-like region. Aspects of the plant diversity of Saudi Arabia have been documented by Mandaville (1990), Chaudhary (1999) and Chaudhary & Al-Jowaid (1999).

Although chromosome numbers of some species found in Saudi Arabia are known from other parts of their distribution area, there are many which have never been reported previously. Only few species growing in Saudi Arabia were cytologically investigated so far by Al-Turki (1992) and Badr & Gasim (1992). The present study therefore aims at a completion of our knowledge of the cytology of the flowering plants in the Kingdom, providing a basis for nature conservation and other applied programs as well as for taxonomic, genetic and molecular studies. In this study, chromosome numbers of 31 taxa belonging to 14 families of flowering plants are provided.

Material and methods

Plants or seeds of the taxa investigated were collected from seven provinces of the Kingdom of Saudi Arabia between 1994 and 2000. The collecting data for each provenance are given in detail. The plants were identified by staff members of the Herbarium of the King Abulaziz City for Science and Technology (KACST), Riyadh, using the works of Migahid (1978), Miller & Cope (1996), Collenette (1999) and Chaudhary (1999). Voucher specimens of all 31 taxa studied were deposited in the KACST herbarium.

Chromosome counts were made from metaphase plates of mitotic division in root tips of seedling germinated in 90 mm plastic petri-dishes on two layers of Whatman No.1 filter paper moistened with distilled water. They were incubated at 25 °C for 12 h in the light and 15 °C for 12 h in the dark in each 24 h cycle. The cytological preparations were made according to the technique described by Darlington & La Cour (1976): root-tips were excised in the morning, pretreated with 0.002M 8-hydroxyquinoline for 5 h at 20 °C, fixed in freshly prepared acetic-alcohol solution (3:1) and, after a brief wash, hydrolysed in 1N HCl for 10-15 min at 60 °C. Following standard aceto-orcein squash technique, root tips were subjected to 0.2% aceto-orcein solution for 30-60 min except for *Silene* and *Salvia* material which were stained by Feulgen's reagent. Preparations were dehydrated by quick freezing in liquid carbon dioxide (Jacobson 1965) and finally mounted in euparal. Best observations, from an average of 30 cells, were photographed using the 100× oil immersion phase contrast objective of a Leica DMRBE photomicroscope.

For the karyotype analysis individual chromosomes were cut from the photographs of well separated metaphases, arranged in a descending order of their length and grouped to form homologous pairs on the basis of gross morphology and centromere position (Fig. 1-2). Measurements for short and long arms and total length of the chromosomes for five different metaphases of each species were done using the Ikaros program on an image analyzer of MetaSystems GmbH (Table 1-6), which helped in reducing the error factor to minimal. The nomenclature of Levan & al. (1964) has been used to determine the centromere position as median (M, with a ratio long : short arm (L/S) = 1.0 and m, with L/S = 1.0-1.7), sub-median (sm) or sub-terminal (st). The karyotype formulae (see Table 1-6) are given according to the definitions by Subramanian (1988): B and C = chromosomes of 4-5 µm length with submedian (B) or median (C) centromere; E and F = chromosomes of 3-3.9 µm length with submedian (E) or median (F) centromere; I = chromosomes of 2-2.9 µm length with median centromere.

The chromosome number indexes by Fedorov (1969), Moore (1973-77), Goldblatt (1981-88), Goldblatt & Johnson (1990-96) were evaluated for previous chromosome number reports.

Results and discussion

The chromosome numbers determined for 31 taxa are the first reports from Saudi Arabian populations. Of these, the chromosome numbers for six species, viz. *Anabasis setifera*, *Cleome amblyocarpa*, *Halopeplis perfoliata, Lavandula coronopifolia, Lycium shawii* and *Salvia deserti* were not known before; for two species, *Asphodelus tenuifolius* and *Heliotropium lasiocarpum,* a new basic number and/or a new ploidy level is reported. Three of the counted species, *Abrus precatorious, Amaranthus spinosus* and *Sesuvium sesuvioides,* are widespread non-endemics but considered as endangered in Saudi Arabia (Collenette 1998, 1999).

The species investigated are listed by their families in alphabetical order.

Aizoaceae

Sesuvium sesuvioides (Fenzl) Verd., 2n=16
Syn.: *Diplochonium sesuvioides* Fenzl; *Trianthema polysperma* Hochst. ex Oliv.
EASTERN PROVINCE: Anak, Dammam, east of city, coastal area, saline, sea flooded soil, 26º8'N, 49º72'E, 18.10.1994, *Al-Turki & Abdul Ghafoor 152* (KACST).

Our report corroborates the gametic count of n=8 by Khatoon (1991); a tetraploid number of

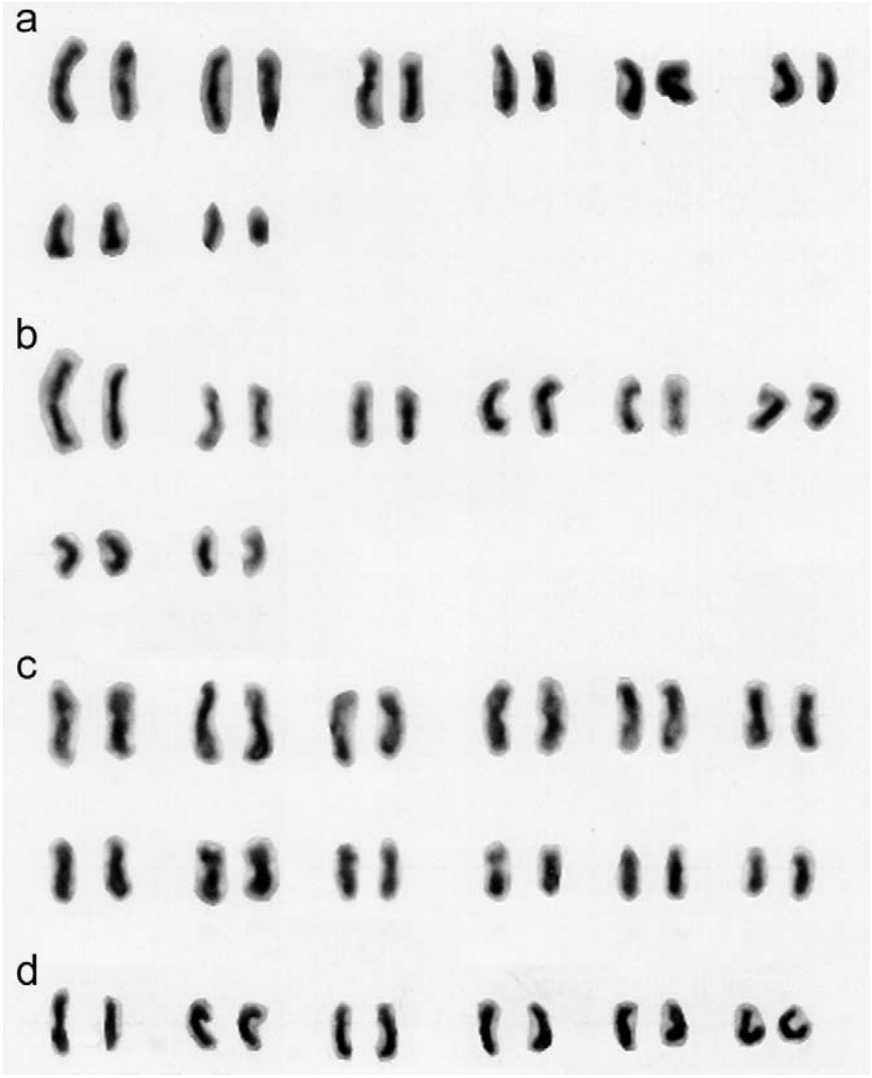

Fig. 1. Karyograms – a: *Alhagi camelorum* (2n=16); b: *Astragalus abyssinicus* (2n=16); c: *Datura innoxia* (2n=24); d: *Moltkiopsis ciliata* (2n=12). See text and Tables 1-4.

2n=32 was found by Bittrich (1986). Karyogram and karyotype analysis are shown in Fig. 2a and Table 5 respectively.

The species is considered as endangered in Saudi Arabia (Collenette 1998, 1999) but is widespread elsewhere and has also been reported from the neighbouring Yemen (Miller & Cope 1996). Flowering time: October-November.

Amaranthaceae

Amaranthus spinosus L., 2n=34

JIZAN PROVINCE: Jabal Fiyfa, Jizan, 16º54'N, 42º32'E, 9.6.1999, *Al-Turki, Al-Farhan & Thomas 3785* (KACST).

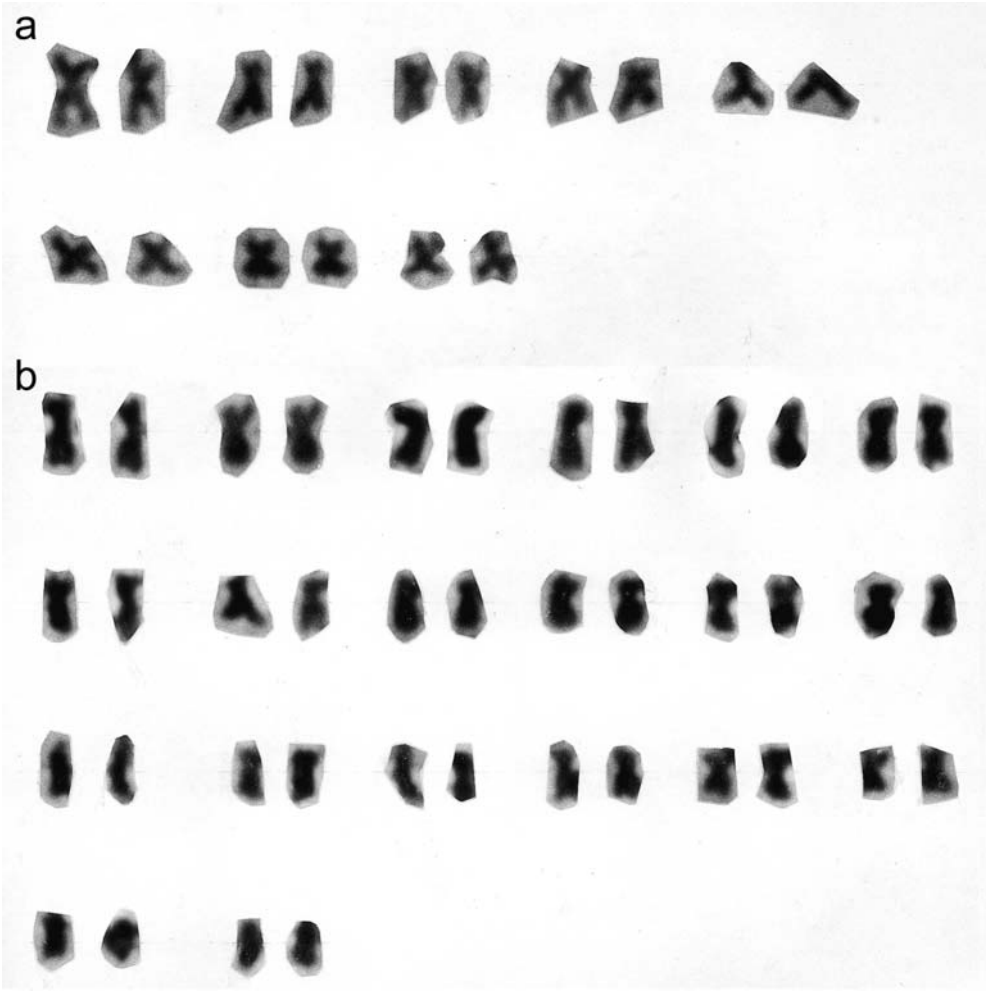

Fig. 2. Karyograms – a: *Sesuvium sesuviodes* (2n=16); b: *Rumes dentatus* (2n=40). See text and Tables 5-6.

Our count agrees with the somatic counts reported by Tandon & Tawakley (1970), Bir & Sidhu (1980), Renard & al. (1983), Baquar & Olusi (1988), Paiva & Leitão (1989) and Greizerstein & Poggio (1992) and the gametic counts of n=17 by Sharma (1970 according to Goldblatt 1981), Koul & al. (1976), Behera & Patnaik (1977, 1982) and Sidhu (1979 according to Goldblatt 1984).

This pantropical weed is rare in Saudi Arabia and has been classified as endangered by Collenette (1998, 1999). Flowering time: June-July.

Asclepiadaceae

Leptadenia pyrotechnica (Forssk.) Decne., 2n=22
Syn.: *Cynanchum pyrotechnicum* Forssk.
RIYADH PROVINCE: Wadi Ad-Degha, Salboukh, 72 km NW of Riyadh, 25º01'N, 46º18'E, 22.12.1998, *Al-Turki & Swarup 2803B* (KACST).

This report agrees with the previous report by Baquar & Hussain (1967).

This shrub is very widespread in Saudi Arabia, occurring from sea level to 4000 ft (Collenette 1999). Flowering time: December-January.

Boraginaceae

Heliotropium lasiocarpum Fisch. & C. A. Mey., 2n=32
RIYADH PROVINCE: Dirab, 35 km SW from Riyadh, 25º48'N, 46º48'E, 12.4.1995, *Al-Turki 842* (KACST).

We are aware of only two previous reports for this species: one of a hexaploid cytotype (2n=48; Podlech & Bader 1974) and the other of a octoploid cytotype (n=32; Khatoon 1991). This is apparently the first report of a tetraploid cytotype of this species.

This leafy, branched herb with tiny white flowers is a frequent weed of irrigated land. Flowering time: April-May.

Moltkiopsis ciliata (Forssk.) I. M. Johnston, 2n=12
Syn.: *Lithospermum ciliatum* Forssk.; *L. angustifolium* Forssk.; *L. callosum* Vahl
RIYADH PROVINCE: 72 km from Riyadh to Dammam highway, 25º02'N, 47º00'E, 21.3.1999, *Al-Turki, Swarupanandan & Mehmood 3751* (KACST).

We are aware of only one previous report for this species (Amin 1979), also giving 2n=12. Karyogram and karyotype analysis are shown in Fig. 1d and Table 4 respectively.

Two varieties can be recognized in the single species of this genus (Al-Turki & Swarupan in prep.); the material investigated here belongs to var. *ciliata*. *Moltkiopsis ciliata* is distributed from N Africa to Iran. Flowering time: March-April.

Caesalpiniaceae

Senna alexandrina Mill., 2n=28
Syn.: *Cassia senna* L.; *C. medica* Forssk.; *C. ligustrina* sensu Forssk.; *C. angustifolia* Vahl; *C. acutifolia* Del. (1802); *C. alexandrina* (Mill.) Thell.
JIZAN PROVINCE: Wadi Besh, near Sabya, Jizan, 17º25'N, 42º25'E, 8.6.1999, *Al-Turki & Thomas 3784* (KACST).

Previous counts have been published under the synonym *Cassia senna* by Khatoon (1991) and George & Bhavandan (1993) and are in agreement with our counts.

A medicinally important plant, which is quite common in Hijaz and other areas. Flowering time: May-July.

Capparaceae

Capparis spinosa L., 2n=38
Syn.: *Capparis aegyptiaca* Lam.; *C. leucophylla* DC.; *C. mucronifolia* Boiss.; *C. elliptica* Haussk. & Bornm.
RIYADH PROVINCE: Diriya, c.10 km W of Riyadh, in the wadi, 24º09'N, 46º12'E, 21.7.1994, *Al-Turki & Abdul Ghafoor 40* (KACST).

Our count agrees with those reported by Murin & Chaudhri (1970) and Magulaev (1979 according to Goldblatt 1984).

The widely distributed English caper is also widespread in Saudi Arabia (Chaudhary 1999). Flowering time: June-July.

Cleome amblyocarpa Barratte & Murb., 2n=20
Syn.: *Cleome arabica* auct., non. L.; *Siliquaria glandulosa* Forssk.; *C. africana* Botsch.
HAIL PROVINCE: As-Sayyirah, near HADCO company, Hail, 26º05'N, 44º00'E, 25.4.1999, *Al-Turki & Mehmood 3155* (KACST).

This is the first report of the chromosome number of this species.

Cleome amblyocarpa is widely distributed in the Arabian Peninsula and extends to the Saharo-Sindian and Irano-Turanian regions. Flowering time: April-May.

Caryophyllaceae

Silene apetala Willd., 2n=24
RIYADH PROVINCE: Wadi Degha, Salboukh, 25º50'N, 46º25'E, 28.12.1997, *Al-Turki & Mehmood 2110A* (KACST).

Our count agrees with the reports by Loon & Jong (1978), Amin (1979) and Degraeve (1980).

A widely distributed, slender annual herb with a prominently 10-nerved calyx and pink petals. The seeds are distinctly winged, grooved and papillose. Flowering time: December-January.

Chenopodiaceae

Anabasis setifera Moq., 2n=18
EASTERN PROVINCE: Darin, Saudi Arabian Gulf coast, 26º33'N, 50º04'E, 17.11.1994, *Al-Turki & Abdul Ghafoor 217* (KACST).

We have found no previous chromosome number report for this species. The number counted has also been found in other species of the genus, such as *A. articulata* (Forssk.) Moq.-Tand. (Murin & Chaudhri 1970) and *A. brevifolia* C. A. Mey. (Lomonosova & Krasnikov 1993).

A widely distributed perennial herb with a woody base, fleshy green stems and tiny fleshy leaves. Flowering time: October-November.

Bienertia cycloptera Bunge, 2n=18
EASTERN PROVINCE: Darin, Saudi Arabian Gulf coast, 26º33'N, 50º04'E, 18.10.1994, *Al-Turki & Abdul Ghafoor 156* (KACST).

The chromosome number obtained for this species corroborates the reports by Murin & Chaudhri (1970) and Khatoon (1991, n=9).

An annual herb with wide, fleshy, dark green leaves, known from scattered localities in the eastern part of the country. Flowering time: September-October.

Chenopodium album L., 2n=54
AL-BAHA PROVINCE: Al-Baha, wasteland in the city, 20º00'N, 41º27'E, 13.5.2000, *Al-Turki & Swarupanandan 5003* (KACST).

Our count agrees with the previously published reports (Cole 1962, Uotila 1973, Tanaka & Tanaka 1980, Schwarzová 1986, Palomino & al. 1990).

A widespread and variable, sparsely branching, leafy herb with its tiny bud-like flowers with yellow stamens conglomerate in axillary and terminal panicles. Flowering time: April-May.

Chenopodium ambrosioides L., 2n=32
Syn. : *C. anthelminticum* L.
AL-BAHA PROVINCE: Al-Baha, wasteland in the city, 20º00'N, 41º27'E, 13.5.2000, *Al-Turki & Swarupanandan 5024* (KACST).

The chromosome count for this species is consistent with previous reports, by, e.g., Lorz (1937), Uotila (1973), Queiros (1975), Koul & al. (1976), Tanaka & Tanaka (1980) and Schwarzová (1986).

Palomino & al. (1990) substantiated the placement of *C. ambrosioides* and the closely related *C. graveolens* in the separate genus *Teloxys* by cytogenetic data. An aromatic, branching herb with unevenly lobed leaves and the bud-like flowers conglomerate in the leaf axiles. Usually along ditches and well-watered areas. Flowering time: April-May.

Chenopodium ficifolium Sm., 2n=18.
RIYADH PROVINCE: Dirab, c. 35 km SW of Riyadh, 25º48'N, 46º48'E, 12.5.1995, *Al-Turki & Abdul Ghafoor 850* (KACST).

Our count for this species is in agreement with previous reports (Uotila 1973 and see Fedorov 1969).

A mealy whitish-green annual herb, occurring as a weed in central and eastern Saudi Arabia, often confused with *C. album* L. (Chaudhary 1999). Flowering time: March-April.

Chenopodium glaucum L., 2n=18
RIYADH PROVINCE: Wadi Al'Hair, c. 30 km S of Riyadh, 24º25'N, 46º50'E, 12.5.1995, *Al-Turki & Abdul Ghafoor 840* (KACST).

Our count agrees with the previous reports by Hara (1952), Podlech & Dieterle (1969), Uotila (1973) and Tanaka & Tanaka (1980).

This sprawling herb with ridged stems and glossy, glaucous leaves is a locally noxious weed of cultivated areas and greenhouses in Saudi Arabia. Flowering time: March-April.

Chenopodium murale L., 2n=18
AL-BAHA PROVINCE: Al-Baha, wasteland in the city, 20º00'N, 41º27'E, 13.5.2000, *Al-Turki & Swarupanandan 4999* (KACST).

Our count is consistent with the previous reports by Mehra & Malik (1963), Giusti (1964), Kliphuis & Wieffering (1972) and Uotila (1973).

A variable annual herb fairly widespread as a weed in Saudi Arabia. Flowering time: March-April.

Halocnemum strobilaceum (Pallas) M. Bieb., 2n=18
Syn.: *Salicornia strobilacea* Pallas; *S. cruciata* Forssk.; *Halopeplis strobilacea* (Pallas) Cesati, Passer & Gibelli
EASTERN PROVINCE: Darin, Gulf coast, 26º33'N, 50º04'E, 18.10.1994, *Al-Turki & Abdul Ghafoor 155* (KACST).

Our count corroborates previous counts by Bhattacharya & al. (1971), Zeybek & al. (1977), Hekmat-Shoar & Manafi (1982) and Khatoon (1991, n=9).

A stiffly erect grey-green bushy shrublet with slender branches; a halophyte occurring in scattered localities of the east and northwest coasts. Flowering time: September-October.

Halopeplis perfoliata (Forssk.) Bunge ex Schweinf., 2n=18
EASTERN PROVINCE: Darin, Gulf coast, 26º33'N, 50º04'E, 19.10.1994, *Al-Turki & Abdul Ghafoor 165* (KACST).

Apparently the first chromosome number report for this species. The only other species of the genus investigated caryologically, *H. amplexicaulis* (Vahl) Cesati & al., has also 2n=18 (Blanche & Molero 1987).

A basally woody succulent herb with the stems composed of large, green fleshy, obovoid segments; a halophyte widespread along the coasts. Flowering time: September-October.

Labiatae

Lavandula coronopifolia Poir., 2n=42
HAIL PROVINCE: Jabl Aja, Hail, 27º37'N, 41º40'E, 26.4.1999, *Al-Turki & Mehmood 3240* (KACST).

The first chromosome number report for this eastern Saharo-Arabian and Sudanian subshrub. It grows in shallow ravines at elevations up to 3500ft and is widespread in Saudi Arabia. Flowering time: March-April.

Salvia aegyptiaca L., 2n=28
Syn.: *S. arida* Salisb. (1796), *Thymus hirtus* Viv.
QASSIM PROVINCE: Dukhna, Qassim, 25º03'N, 43º24'E, 1.5.1996, *Al-Turki 1542* (KACST).

Our count agrees with the counts reported by Delestaing (1954) and Borgen (1980).

A small subshrub variable in flower size and the shade of flower colour, very widespread on shallow sand or silt, often in rocky terrain. Flowering time: May-June.

Salvia deserti Decne., 2n=48
QASSIM PROVINCE: Dukhna, Qassim, 25º03'N, 43º 24'E, 1.5.1996, *Al-Turki 1533* (KACST).

We are not aware of any previous chromosome number report for *Salvia deserti* Decne. (not to be confused with *S. deserta* Schang., with 2n=14, Patudin & al. 1975, and 2n=16, Zakirova &

Nafanailova 1988, Nafanailova & Zakirova 1991). Our count of 2n=48 indicates a hexaploid chromosome complement with the basic number x=8.

A leafy shrublet with very rugose leaves and pale blue or white flowers. Flowering time: May-June.

Salvia spinosa L., 2n=20
Syn.: *Salvia aegyptiaca* L. (1767), non L. (1753)
RIYADH PROVINCE: Wadi Degha, Salboukh, 25º52'N, 46º21'E, 28.12.1997, *Al-Turki & Mehmood 2110B* (KACST).

Our count corroborates earlier reports by Yakovleva (1933), Patudin & al. (1975) and Kliphuis & Barkoudah (1977).

A strongly aromatic, small, white-flowered, perennial herb with spinose calyx teeth; leaves, branches and inflorescence with an indumentum of soft, spreading, crisped hairs. Flowering time: December-January.

Liliaceae

Asphodelus tenuifolius Cav., 2n=52
MECCA PROVINCE: Wadi Heet, Al-Ghuwayga, Shafa mountain, Taif, 21º03'N, 40º19'E, 17.5. 1999, *Al-Turki & Abdul Ghafoor 3456* (KACST).

Our counts revealed a new basic number (x=13) and, for the first time (see also Díaz Lifante & Valdés 1996), a tetraploid cytotype for this species. All previous reports give a diploid chromosome complement and a basic number of either x=14 (Podlech 1986, Ruiz Rejon & al. 1990, Díaz Lifante 1991, Díaz Lifante & al. 1992) or x=15 (Sidhu [1979 according to Goldblatt 1984], Bir & Sidhu 1980), the latter basic number reports omitted by Díaz Lifante & Valdés (1996). A tetraploid chromosome complement with a basic number of x=13, as found by us for *A. tenuifolia,* has so far been reported exclusively from *A. refractus* (Díaz Lifante 1992, see also Díaz Lifante & Valdés 1996). A confusion with the latter species can be excluded according to the key given by Díaz Lifante & Valdés (1996) and the different distribution and ecology of the two species. *A. refractus* seems rare in Saudi Arabia and confined to rather deep sands in the eastern and central regions (Mandaville 1990, Collenette 1998, 1999); it has never been recorded from the Taif region. Our count gives further support to the view that besides the primary basic number of x=14 there are secondary basic numbers in the genus *Asphodelus*.

This extremely widespread species usually occurs in sand pans and on rocky slopes. Flowering time : May-June.

Papilionaceae

Abrus precatorious L., 2n=22
Syn.: *Glycine abrus* L.
AL-BAHA PROVINCE: Jabl Shada, Baha, near Al-Makhwah, 19º51'N, 41º18'E, 19.5.1999, *Al-Turki & Abdul Ghafoor 3620* (KACST).

Our count agrees with the previous reports by Bir & Kumari (1977), Borgen (1980), Yeh & al. (1986), Kumari & Bir (1990) and Gill & Husaini (1986, n=11).

The bright red seeds with a black spot of this perennial vine are poisonous to mammals and used as jewellers' weights. Collenette (1998, 1999) considers it as endangered in Saudi Arabia. Flowering time: March-May.

Alhagi camelorum Fisch., 2n=16 + 2B
RIYADH PROVINCE: Dirab, 35 km SW from Riyadh, 28º48'N, 46º48'E, 9.11.1994, *Al-Turki & Abdul Ghafoor 204B* (KACST).

Our counts agrees with the somatic count reported by Lessani & Chariat-Penahi (1979). Karyogram and karyotype analysis are given in Fig. 1a and Table 1 respectively.

Spiny shrub or shrublet with simple leaves and solitary red flowers laterally on the spines. Flowering time: November-December.

Astragalus abyssinicus Steud. ex A. Rich., 2n=16
MECCA PROVINCE: Wadi Herjal, Shafa mountain, Taif, 21º03'N, 40º19'E, 18.5.1999, *Al-Turki* & *Abdul Ghafoor 3555* (KACST).

The chromosome count corrborates the previous report by Ledingham (1960). Karyogram and karyotype analysis are given in Fig. 1b and Table 2 respectively. Flowering time: May-June.

Polygonaceae

Rumex dentatus Wall., 2n=40
Syn.: *Rumex obtusifolius* sensu Forssk.
AL-BAHA PROVINCE: Al-Baha, wasteland in the city, 20º00'N, 41º27'E, 13.5.2000, *Al-Turki* & *Swarupanandan 5035b* (KACST).

Our count agrees with the previous ones by Kliphuis & Barkoudah (1977), Bir & Sidhu (1979, 1980), Munshi (1983), Garcia & al. (1989) and the gametic count by Koul & Wakhlu (1976). Karyogram and karyotype analysis are shown in Fig. 2b and Table 6 respectively.

This annual herb is a weed of wet and moist cultivated areas widely distributed also in the other countries of Arabian Peninsula. Flowering time: April-May.

Solanaceae

Datura innoxia Mill., 2n=24
MECCA PROVINCE: Wadi Heet, Shafa mountain ranges, Taif, 21º03'N, 40º19'E, 17.5.1999, *Al-Turki* & *Abdul Ghafoor 3491B* (KACST).

The count agrees with the previous reports for this species (n=12: Bir & al. 1978, Bir & Neelam 1984, Husaini & Iwo 1990, Sinha 1991; 2n=24: Ma & al. 1985, Palomino & al. 1988, Ge & Lou 1990). Karyogram and karyotype analysis are given in Fig. 1c and Table 3 respectively.

A fairly widespread plant, especially in the lowlands. Flowering time : May-June.

Lycium shawii Roem. & Schult., 2n=24
AL-QASSIM PROVINCE: Al-Awshaziya, 26º05'N, 44º00'E, 9.2.1999, *Al-Turki & Mehmood 3750* (KACST).

This is the first chromosome number report for *Lycium shawii.* The same chromosome number has also been reported for other members of the genus, e.g., *L. depressum* Stocks (Lessani & Chariat-Panahi 1979) and *L. edgeworthii* Dunal (Khatoon 1991, n=12).

This variable shrub with white to deep blue flowers and orange coloured edible berries is widespread in Saudi Arabia. Flowering time: February-March.

Withania somnifera (L.) Dun., 2n=48
Syn.: *Physalis curassavica* sensu Forssk.; *P. somnifera* L.
RIYADH PROVINCE: Dirab, between Riyadh and Hafiratun Nisah, 25º48'N, 46º42'E, 13.5.1997, *Al-Turki & Abdul Ghafoor 1970* (KACST).

Our count agrees with those reported by Vasudevan (1975 according to Goldblatt 1981), Bir & al. (1978), Bir & Neelam (1980), Bir & Sidhu (1979, n=24), Bir & Sidhu (1980), Khatoon & Ali (1982), Renard & al. (1983), Salvik & al. (1993) and Sidhu (1979, n=24, according to Goldblatt 1984). Bir & Neelam (1984) in contrast reported a count of n=36 for this species.

A very common and widespread plant of waste places, with orange coloured berries, which are enveloped by a papery, inflated and persistent calyx. Flowering time: April-May.

Zygophyllaceae

Zygophyllum coccineum L., 2n=16
Syn.: *Zygophyllum desertorum* Forssk.

EASTERN PROVINCE: Dammam, c.1 km from sea, sandy soil, 26º42'N, 52º04'E, 19.10.1994, *Al-Turki & Abdul Ghafoor 163* (KACST).

Our count agrees with the previous report by Hilu (1979).

A small annual herb with fleshy leaves and somewhat whitish flowers of saline and sandy habitats near the sea. Flowering time: October-November.

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Table 1. Karyotype analysis of five different metaphases of *Alhagi camelorum*.
L/S = long / short arm ratio, P.O.C. = position of centromere, M, m = median, sm = submedian.

Karyotype number	Parameters [μm]	Pair # 1		Pair # 2		Pair # 3		Pair # 4		Pair # 5		Pair # 6		Pair # 7		Pair # 8	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Short arm (S)	2.19	2.48	1.30	1.50	1.51	1.43	1.79	1.61	1.39	1.11	1.65	1.82	1.23	1.52	1.44	0.92
	Long arm (L)	3.42	2.66	3.81	3.56	3.39	3.35	2.64	2.70	2.82	2.80	2.25	1.90	2.07	1.73	1.65	1.12
	Total length	5.61	5.14	5.11	5.06	4.90	4.78	4.43	4.31	4.21	3.91	3.90	3.72	3.30	3.25	3.09	2.04
	L / S	1.56	1.07	2.93	2.37	2.24	2.34	1.47	1.67	2.03	2.52	1.36	1.04	1.68	1.14	1.14	1.22
	P. O. C.	m	m	sm	sm	sm	sm	m	m	sm	sm	m	m	m	m	m	m
2.	Short arm (S)	2.18	2.48	1.31	1.50	1.52	1.43	1.80	1.62	1.37	1.11	1.66	1.82	1.24	1.51	1.43	0.93
	Long arm (L)	3.43	2.64	3.82	3.55	3.38	3.34	2.65	2.70	2.80	2.81	2.27	1.90	2.06	1.72	1.64	1.12
	Total length	5.61	5.12	5.13	5.05	4.90	4.77	4.45	4.32	4.17	3.92	3.93	3.72	3.30	3.23	3.07	2.05
	L / S	1.57	1.06	2.92	2.36	2.22	2.33	1.47	1.66	2.64	2.53	1.36	1.04	1.66	1.14	1.14	1.20
	P. O. C.	m	m	sm	sm	sm	sm	m	m	sm	sm	m	m	m	m	m	m
3.	Short arm (S)	2.19	2.47	1.29	1.49	1.51	1.44	1.78	1.63	1.40	1.11	1.65	1.81	1.22	1.52	1.45	0.92
	Long arm (L)	3.43	2.66	3.81	3.54	3.39	3.37	2.63	2.72	2.83	2.80	2.25	1.89	2.06	1.73	1.66	1.12
	Total length	5.62	5.13	5.10	5.03	4.90	4.81	4.41	4.35	4.23	3.91	3.90	3.70	3.28	3.25	3.11	2.04
	L / S	1.56	1.07	2.95	2.37	2.24	2.34	1.47	1.67	2.02	2.52	1.36	1.04	1.68	1.14	1.14	1.22
	P. O. C.	m	m	sm	sm	sm	sm	m	m	sm	sm	m	m	m	m	m	m
4.	Short arm (S)	2.18	2.47	1.32	1.51	1.50	1.43	1.77	1.62	1.39	1.10	1.64	1.81	1.24	1.53	1.44	0.91
	Long arm (L)	3.42	2.63	3.83	3.57	3.40	3.35	2.65	2.71	2.82	2.79	2.24	1.90	2.08	1.74	1.65	1.11
	Total length	5.60	5.10	5.15	5.08	4.90	4.78	4.42	4.33	4.21	3.89	3.88	3.71	3.32	3.27	3.09	2.02
	L / S	1.56	1.06	2.90	2.36	2.26	2.34	1.49	1.67	2.03	2.53	1.36	1.04	1.67	1.13	1.13	1.21
	P. O. C.	m	m	sm	sm	sm	sm	m	m	sm	sm	m	m	m	m	m	m
5.	Short arm (S)	2.19	2.47	1.31	1.51	1.52	1.44	1.81	1.61	1.38	1.12	1.65	1.83	1.23	1.51	1.43	0.91
	Long arm (L)	3.42	2.65	3.81	3.55	3.39	3.36	2.66	2.70	2.81	2.81	2.25	1.91	2.07	1.72	1.64	1.13
	Total length	5.61	5.12	5.12	5.06	4.91	4.80	4.47	4.31	4.19	3.93	3.90	3.74	3.30	3.23	3.07	2.04
	L / S	1.56	1.07	2.90	2.35	2.35	2.23	1.46	1.67	2.03	2.51	1.36	1.04	1.68	1.14	1.14	1.24
	P. O. C.	m	m	sm	sm	sm	sm	m	m	sm	sm	m	m	m	m	m	m
	Mean length	5.61	5.13	5.19	5.06	4.90	4.79	4.43	4.32	4.21	3.91	3.90	3.72	3.30	3.25	3.09	2.04
	Standard error	0.003	0.008	0.009	0.008	0.002	0.006	0.01	0.008	0.006	0.006	0.004	0.006	0.006	0.006	0.006	0.004

Total chromosome length: 66.7 μm; Range of mean length of individual chromosomes: 5.6-2.0 μm

Karyotype formula: 2n=16 = B6 + C4 + F5 + I1

Table 2. Karyotype analysis of five different metaphases of *Astragalus abyssinicus*.
L/S = long / short arm ratio, P.O.C. = position of centromere, M, m = median, sm = submedian.

Karyotype number	Parameters [µm]	Pair # 1		Pair # 2		Pair # 3		Pair # 4		Pair # 5		Pair # 6		Pair # 7		Pair # 8	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Short arm (S)	3.37	3.17	1.19	1.19	1.15	1.13	1.74	1.95	1.90	1.82	1.46	1.77	1.49	1.34	1.54	1.52
	Long arm (L)	3.60	3.40	3.33	3.22	2.97	2.97	2.31	2.05	2.07	2.12	2.44	1.83	2.06	2.04	1.79	1.67
	Total length	6.97	6.57	4.52	4.41	4.12	4.10	4.05	4.00	3.97	3.94	3.90	3.60	3.55	3.38	3.33	3.19
	L / S	0.94	1.07	2.80	2.70	2.58	2.63	1.32	1.05	1.09	1.65	1.67	1.03	1.38	1.52	1.16	1.10
	P. O. C.	m	m	sm	sm	sm	sm	m	m	m	m	m	m	m	m	m	m
2.	Short arm (S)	3.41	3.10	1.18	1.19	1.17	1.14	1.73	1.95	1.90	1.81	1.45	1.78	1.50	1.35	1.53	1.51
	Long arm (L)	3.63	3.38	3.32	3.21	2.98	2.95	2.34	2.04	2.08	2.13	2.46	1.84	2.07	2.03	1.80	1.68
	Total length	7.04	6.48	4.50	4.40	4.15	4.09	4.07	3.99	3.98	3.94	3.91	3.62	3.57	3.38	3.33	3.19
	L / S	1.06	1.09	2.81	2.69	2.54	2.58	1.35	1.05	1.09	1.17	1.69	1.03	1.38	1.50	1.17	1.11
	P. O. C.	m	m	sm	sm	sm	sm	m	m	m	m	m	m	m	m	m	m
3.	Short arm (S)	3.35	3.19	1.20	1.18	1.16	1.13	1.74	1.93	1.91	1.81	1.46	1.79	1.49	1.35	1.55	1.52
	Long arm (L)	3.59	3.39	3.34	3.21	2.99	2.96	2.33	2.02	2.05	2.12	2.45	1.85	2.05	2.05	1.78	1.68
	Total length	6.94	6.58	4.54	4.39	4.15	4.09	4.07	3.95	3.96	3.93	3.91	3.64	3.54	3.40	3.33	3.20
	L / S	1.07	1.06	2.78	2.72	2.57	2.62	1.34	1.05	1.07	1.17	1.67	1.03	1.37	1.52	1.15	1.10
	P. O. C.	m	m	sm	sm	sm	sm	m	m	m	m	m	m	m	m	m	m
4.	Short arm (S)	3.36	3.21	1.18	1.18	1.15	1.12	1.75	1.94	1.93	1.84	1.47	1.77	1.48	1.33	1.55	1.50
	Long arm (L)	3.60	3.43	3.35	3.23	2.98	2.97	2.31	2.07	2.07	2.13	2.44	1.83	2.04	2.02	1.79	1.65
	Total length	6.96	6.64	4.53	4.41	4.13	4.09	4.06	4.01	4.00	3.97	3.91	3.60	3.52	3.35	3.34	3.15
	L / S	1.07	1.07	2.83	2.73	2.59	2.65	1.32	1.06	1.07	1.15	1.65	1.03	1.38	1.52	1.15	1.10
	P. O. C.	m	m	sm	sm	sm	sm	m	m	m	m	m	m	m	m	m	m
5.	Short arm (S)	3.36	3.13	1.21	1.19	1.16	1.14	1.76	1.95	1.92	1.82	1.45	1.76	1.49	1.33	1.54	1.51
	Long arm (L)	3.59	3.42	3.35	3.21	2.97	2.96	2.29	2.04	2.06	2.12	2.43	1.82	2.06	2.03	1.80	1.67
	Total length	6.95	6.55	4.56	4.40	4.13	4.10	4.05	3.99	3.98	3.94	3.88	3.58	3.55	3.36	3.34	3.18
	L / S	1.06	1.09	2.76	2.69	2.56	2.59	1.30	1.05	1.07	1.16	1.67	1.03	1.38	1.52	1.17	1.10
	P. O. C.	m	m	sm	sm	sm	sm	m	m	m	m	m	m	m	m	m	m
	Mean length	6.97	6.56	4.53	4.40	4.14	4.10	4.10	3.99	3.98	3.94	3.90	3.61	3.55	3.37	3.33	3.18
	Standard error	0.018	0.026	0.01	0.004	0.006	0.003	0.005	0.01	0.006	0.007	0.006	0.01	0.008	0.009	0.003	0.009

Total chromosome length: 69.3 µm; Range of mean length of individual chromosomes: 7.0-3.1 µm
Karyotype formula: 2n=16 = B4 + C4 + F8

Table 3. Karyotype analysis of five different metaphases of *Datura innoxia*.
L/S = long / short arm ratio, P.O.C. = position of centromere, M, m = median, sm = submedian.

Karyo-type	Parameters [µm]	Pair # 1		Pair # 2		Pair # 3		Pair # 4		Pair # 5		Pair # 6		Pair # 7		Pair # 8		Pair # 9		Pair # 10		Pair # 11		Pair # 12	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
1.	Short arm (S)	2.64	2.28	2.31	2.59	1.75	1.53	2.46	2.45	2.49	2.49	2.34	2.43	2.22	1.73	1.66	1.75	1.49	1.99	1.34	1.49	0.92	1.00	1.39	1.32
	Long arm (L)	3.88	3.87	3.41	2.88	3.72	3.84	2.83	2.83	2.68	2.64	2.68	2.49	2.67	2.90	2.80	2.68	2.52	2.01	2.24	1.94	2.46	2.16	1.42	1.37
	Total length	6.52	6.15	5.72	5.47	5.47	5.37	5.29	5.28	5.17	5.13	5.02	4.92	4.89	4.63	4.46	4.43	4.01	4.00	3.58	3.43	3.38	3.16	2.81	2.69
	L / S	1.46	1.69	1.47	1.11	2.12	2.50	1.15	1.15	1.07	1.06	1.14	1.02	1.20	1.67	1.68	1.53	1.69	1.01	1.67	1.30	2.67	2.16	1.02	1.69
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	sm	sm	m	m
2.	Short arm (S)	2.65	2.27	2.30	2.61	1.76	1.54	2.45	2.45	2.50	2.48	2.33	2.42	2.21	1.73	1.65	1.75	1.50	1.99	1.33	1.48	0.93	1.01	1.38	1.31
	Long arm (L)	3.87	3.87	3.40	2.89	3.72	3.83	2.82	2.84	2.69	2.64	2.68	2.48	2.66	2.91	2.81	2.68	2.51	2.01	2.25	1.94	2.45	2.17	1.43	1.36
	Total length	6.52	6.14	5.70	5.50	5.48	5.37	5.27	5.29	5.19	5.12	5.01	4.90	4.87	4.64	4.16	4.43	4.01	4.00	3.58	3.42	3.38	3.18	2.81	2.67
	L / S	1.46	1.70	1.47	1.10	2.11	2.48	1.15	1.16	1.07	1.06	1.15	1.02	1.20	1.68	1.70	1.53	1.24	1.01	1.69	1.31	2.63	2.14	1.03	1.03
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	sm	sm	m	m
3.	Short arm (S)	2.63	2.26	2.30	2.57	1.74	1.52	2.45	2.43	2.49	2.46	2.32	2.44	2.20	1.72	1.65	1.74	1.48	1.99	1.35	1.47	0.91	1.00	1.39	1.31
	Long arm (L)	3.88	3.86	3.41	2.86	3.73	3.83	2.83	2.82	2.67	2.62	2.67	2.50	2.67	2.90	2.80	2.69	2.51	2.00	2.24	1.93	2.46	2.15	1.41	1.37
	Total length	6.51	6.12	5.71	5.43	5.47	5.35	5.28	5.25	5.16	5.08	4.99	4.94	4.87	4.62	4.45	4.43	3.99	3.99	3.59	3.40	3.37	3.15	2.80	2.68
	L / S	1.47	1.70	1.48	1.11	2.14	2.51	1.15	1.16	1.07	1.06	1.15	1.02	1.21	1.68	1.69	1.54	1.69	1.00	1.65	1.31	2.70	2.15	1.01	1.04
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	sm	sm	m	m
4.	Short arm (S)	2.63	2.28	2.32	2.58	1.76	1.54	2.47	2.46	2.49	2.47	2.35	2.42	2.23	1.73	1.66	1.73	1.49	1.98	1.33	1.48	0.92	0.99	1.38	1.33
	Long arm (L)	3.87	3.87	3.43	2.87	3.70	3.85	2.82	2.84	2.68	2.63	2.67	2.49	2.69	2.89	2.79	2.68	2.52	2.01	2.23	1.93	2.46	2.17	1.42	1.38
	Total length	6.50	6.15	5.75	5.45	5.46	5.39	5.29	5.30	5.17	5.10	5.02	4.91	4.92	4.62	4.45	4.41	4.01	3.99	3.56	3.41	3.38	3.16	2.80	2.71
	L / S	1.47	1.69	1.47	1.11	2.10	2.50	1.14	1.15	1.07	1.06	1.14	1.02	1.20	1.67	1.68	1.55	1.69	1.01	1.67	1.30	2.67	2.19	1.02	1.03
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	sm	sm	m	m
5.	Short arm (S)	2.64	2.27	2.32	2.60	1.74	1.53	2.46	2.46	2.48	2.48	2.34	2.42	2.21	1.74	1.64	1.74	1.49	1.98	1.34	1.49	0.92	1.01	1.39	1.32
	Long arm (L)	3.89	3.86	3.41	2.89	3.73	3.84	2.82	2.84	2.67	2.65	2.68	2.48	2.67	2.91	2.79	2.67	2.52	2.00	2.24	1.95	2.45	2.16	1.42	1.37
	Total length	6.53	6.13	5.73	5.49	5.47	5.37	5.28	5.30	5.15	5.13	5.02	4.90	4.88	4.65	4.43	4.41	4.01	3.98	3.58	3.44	3.37	3.17	2.81	2.69
	L / S	1.47	1.70	1.46	1.11	2.14	2.50	1.14	1.15	1.07	1.06	1.14	1.02	1.21	1.67	1.70	1.53	1.69	1.01	1.67	1.30	2.66	2.13	1.02	1.03
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	m	m	m	m	m	m	m	m	m	m	sm	sm	m	m
	Mean length	6.52	6.14	5.72	5.47	5.47	5.37	5.28	5.28	5.17	5.11	5.01	4.91	4.89	4.63	4.39	4.42	4.01	3.99	3.58	3.42	3.38	3.16	2.81	2.69
	Standard error	0.005	0.006	0.009	0.013	0.003	0.006	0.004	0.009	0.007	0.01	0.006	0.007	0.009	0.006	0.006	0.005	0.004	0.004	0.005	0.007	0.002	0.005	0.002	0.007

Total chromosome length: 110 µm; Range of mean length of individual chromosomes: 6.5-2.6 µm

Karyotype formula: 2n=24 = B2 + C16 + E2 + F2 + I2

Table 4. Karyotype analysis of five different metaphases of *Moltkiopsis ciliata*.
L/S = long / short arm ratio, P.O.C. = position of centromere, M, m = median, sm = submedian

Karyotype number	Parameters [µm]	Pair # 1		Pair # 2		Pair # 3		Pair # 4		Pair # 5		Pair # 6	
		1	2	3	4	5	6	7	8	9	10	11	12
1.	Short arm (S)	2.78	2.44	2.20	2.32	1.82	1.84	1.84	1.79	1.94	1.50	1.43	1.23
	Long arm (L)	3.04	3.05	3.19	2.97	3.17	3.15	2.65	2.55	2.38	2.65	2.66	2.63
	Total length	5.82	5.49	5.39	5.29	4.99	4.99	4.49	4.34	4.32	4.23	4.09	3.86
	L / S	1.09	1.25	1.45	1.28	1.74	1.71	1.44	1.42	1.23	1.67	1.86	2.14
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	sm	sm
2.	Short arm (S)	2.79	2.44	2.21	2.33	1.81	1.85	1.84	1.77	1.95	1.50	1.42	1.23
	Long arm (L)	3.06	3.04	3.20	2.95	3.18	3.16	2.65	2.57	2.39	2.64	2.65	2.62
	Total length	5.85	5.48	5.41	5.28	4.99	5.01	4.49	4.34	4.34	4.14	4.07	3.85
	L / S	1.09	1.24	1.44	1.26	1.75	1.71	1.44	1.45	1.22	1.76	1.86	2.13
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	sm	sm
3.	Short arm (S)	2.78	2.45	2.22	2.31	1.83	1.84	1.85	1.78	1.95	1.49	1.43	1.22
	Long arm (L)	3.05	3.05	3.19	2.97	3.17	3.15	2.67	2.54	2.38	2.64	2.66	2.64
	Total length	5.83	5.50	5.41	5.28	5.00	4.99	4.52	4.32	4.33	4.13	4.09	3.86
	L / S	1.09	1.24	1.44	1.28	1.73	1.71	1.44	1.43	1.22	1.77	1.86	2.16
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	sm	sm
4.	Short arm (S)	2.80	2.43	2.20	2.33	1.82	1.83	1.83	1.80	1.94	1.50	1.44	1.22
	Long arm (L)	3.06	3.06	3.18	2.96	3.16	3.14	2.65	2.56	2.38	2.65	2.65	2.62
	Total length	5.86	5.49	5.38	5.29	4.98	4.97	4.48	4.36	4.32	4.15	4.15	3.84
	L / S	1.09	1.26	1.44	1.27	1.74	1.71	1.45	1.42	1.22	1.76	1.84	2.14
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	sm	sm
5.	Short arm (S)	2.77	2.45	2.19	2.31	1.82	1.85	1.85	1.79	1.93	1.51	1.44	1.24
	Long arm (L)	3.04	3.04	3.18	2.98	3.17	3.16	2.64	2.55	2.37	2.64	2.66	2.64
	Total length	5.81	5.49	5.37	5.29	4.99	5.01	4.49	4.34	4.30	4.15	4.10	3.88
	L / S	1.09	1.24	1.29	1.29	1.74	1.71	1.43	1.42	1.23	1.74	1.84	2.13
	P. O. C.	m	m	m	m	sm	sm	m	m	m	m	sm	sm
	Mean length	5.83	5.49	5.40	5.28	4.99	4.99	4.50	4.33	4.32	4.15	4.09	3.86
	Standard error	0.007	0.004	0.008	0.002	0.002	0.01	0.007	0.005	0.007	0.02	0.005	0.005

Total chromosome length: 52.3 µm; Range of mean length of individual chromosomes: 5.8-3.8 µm
Karyotype formula: 2n=12 = B3 + C8 + E1

Table 5. Karyotype analysis of five different metaphases of *Sesuvium sesuviodes*.
L/S = long / short arm ratio, P.O.C. = position of centromere, M, m = median, sm = submedian.

Karyotype number	Parameters [μm]	Pair # 1		Pair # 2		Pair # 3		Pair # 4		Pair # 5		Pair # 6		Pair # 7		Pair # 8	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Short arm (S)	2.06	1.94	1.87	1.68	1.33	1.51	1.59	1.59	1.43	1.39	1.34	1.14	1.17	1.35	1.30	1.12
	Long arm (L)	2.34	2.31	1.88	1.94	2.27	1.67	1.59	1.59	1.73	1.75	1.72	1.87	1.75	1.35	1.32	1.26
	Total length	4.40	4.25	3.75	3.62	3.60	3.18	3.18	3.18	3.16	3.14	3.06	3.01	2.92	2.70	2.62	2.38
	L / S	1.13	1.19	1.00	1.15	1.92	1.10	1.00	1.00	1.21	1.26	1.28	1.64	1.49	1.00	1.01	1.12
	P. O. C.	m	m	M	m	m	m	M	M	m	m	m	m	m	M	m	m
2.	Short arm (S)	2.05	1.96	1.86	1.67	1.34	1.52	1.60	1.59	1.42	1.40	1.34	1.15	1.17	1.36	1.30	1.13
	Long arm (L)	2.35	2.33	1.88	1.95	2.29	1.68	1.60	1.60	1.78	1.76	1.72	1.89	1.75	1.36	1.32	1.24
	Total length	4.40	4.29	3.74	3.62	3.63	3.20	3.20	3.19	3.20	3.16	3.06	3.04	2.92	2.72	2.62	2.37
	L / S	1.14	1.18	1.01	1.16	1.70	1.10	1.00	1.01	1.25	1.25	1.28	1.64	1.49	1.00	1.01	1.09
	P. O. C.	m	m	m	m	m	m	M	m	m	m	m	m	m	M	m	m
3.	Short arm (S)	2.07	1.95	1.88	1.69	1.33	1.50	1.59	1.55	1.41	1.39	1.31	1.15	1.16	1.35	1.29	1.12
	Long arm (L)	2.36	2.32	1.87	1.96	2.26	1.67	1.59	1.57	1.74	1.76	1.72	1.86	1.75	1.35	1.32	1.26
	Total length	4.43	4.27	3.77	3.65	3.59	3.17	3.18	3.12	3.15	3.15	3.03	3.01	2.91	2.70	2.61	2.38
	L / S	1.14	1.19	1.00	1.15	1.69	1.11	1.00	1.01	1.23	1.26	1.31	1.62	1.50	1.00	1.02	1.12
	P. O. C.	m	m	M	m	m	m	M	m	m	m	m	m	m	M	m	m
4.	Short arm (S)	2.05	1.94	1.89	1.67	1.35	1.52	1.58	1.58	1.43	1.39	1.33	1.14	1.15	1.34	1.31	1.11
	Long arm (L)	2.34	2.31	1.90	1.93	2.27	1.68	1.59	1.58	1.74	1.75	1.71	1.88	1.76	1.35	1.32	1.25
	Total length	4.39	4.25	3.79	3.60	3.62	3.20	3.17	3.16	3.17	3.14	3.04	3.02	2.91	2.69	2.63	2.36
	L / S	1.14	1.19	1.00	1.15	1.68	1.10	1.00	1.00	1.22	1.26	1.28	1.64	1.53	1.01	1.01	1.12
	P. O. C.	m	m	M	m	m	m	M	M	m	m	m	m	m	m	m	m
5.	Short arm (S)	2.06	1.95	1.88	1.68	1.34	1.51	1.57	1.59	1.43	1.38	1.35	1.13	1.16	1.34	1.30	1.11
	Long arm (L)	2.35	2.32	1.89	1.94	2.27	1.68	1.58	1.59	1.73	1.77	1.74	1.86	1.76	1.36	1.33	1.27
	Total length	4.41	4.27	3.77	3.62	3.61	3.19	3.15	3.18	3.16	3.15	3.09	2.99	2.92	2.70	2.63	2.38
	L / S	1.14	1.19	1.00	1.15	1.69	1.11	1.01	1.00	1.21	1.28	1.29	1.65	1.52	1.01	1.02	1.14
	P. O. C.	m	m	M	m	m	m	m	M	m	m	m	m	m	m	m	m
	Mean length	4.41	4.27	3.76	3.62	3.61	3.19	3.18	3.17	3.17	3.15	3.06	3.01	2.92	2.70	2.62	2.37
	Standard error	0.007	0.008	0.009	0.008	0.007	0.006	0.008	0.012	0.009	0.004	0.01	0.008	0.003	0.005	0.004	0.004

Total chromosome length: 52.1 μm; Range of mean length of individual chromosomes: 4.4-2.3 μm
Karyotype formula: 2n=16 = C2 + F10 + I4

Table 6. Karyotype analysis of five different metaphases of *Rumex dentatus*.
L/S = long / short arm ratio, P.O.C. = position of centromere, M, m = median, sm = submedian.

Karyo-type	Parameters [µm]	Pair # 1		Pair # 2		Pair # 3		Pair # 4		Pair # 5		Pair # 6		Pair # 7		Pair # 8		Pair # 9		Pair # 10	
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1.	Short arm (S)	1..98	2.09	1.98	1.89	1.68	1.79	1.70	1.52	1.70	1.52	1.69	1.36	1.40	1.22	1.24	1.35	1.40	1.30	1.31	1.36
	Long arm (L)	2.70	2.34	2.36	2.34	2.36	2.06	2.13	2.09	1.76	1.88	1.70	2.01	1.85	1.99	1.93	1.78	1.67	1.72	1.68	1.60
	Total length	4.68	4.43	4.34	4.23	4.04	3.85	3.83	3.61	3.46	3.40	3.39	3.37	3.25	3.21	3.17	3.13	3.07	3.02	2.99	2.96
	L / S	1.36	1.12	1.19	1.23	1.40	1.15	1.25	1.37	1.03	1.24	1.01	1.48	1.32	1.63	1.56	1.32	1.19	1.32	1.28	1.18
	P. O. C.	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
2.	Short arm (S)	1.97	2.09	1.97	1.90	1.67	1.79	1.71	1.52	1.71	1.51	1.70	1.35	1.41	1.20	1.23	1.35	1.41	1.30	1.32	1.34
	Long arm (L)	2.71	2.33	2.35	2.34	2.35	2.06	2.12	2.08	1.75	1.88	1.71	2.02	1.84	1.99	1.92	1.77	1.68	1.71	1.67	1.61
	Total length	4.68	4.42	4.32	4.24	4.02	3.85	3.83	3.60	3.46	3.39	3.41	3.37	3.25	3.19	3.15	3.12	3.09	3.01	2.99	2.95
	L / S	1.37	1.11	1.19	1.23	1.40	1.15	1.24	1.37	1.02	1.24	1.01	1.49	1.30	1.65	1.56	1.31	1.19	1.31	1.26	1.20
	P. O. C.	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
3.	Short arm (S)	1.99	2.07	1.99	1.88	1.69	1.78	1.69	1.51	1.69	1.51	1.68	1.36	1.41	1.21	1.24	1.34	1.40	1.29	1.32	1.36
	Long arm (L)	2.71	2.35	2.36	2.33	2.36	2.05	2.12	2.10	1.75	1.87	1.70	2.01	1.86	1.99	1.93	1.77	1.67	1.71	1.69	1.60
	Total length	4.70	4.42	4.35	4.21	4.05	3.83	3.81	3.61	3.44	3.38	3.38	3.37	3.27	3.20	3.17	3.11	3.07	3.00	3.01	2.96
	L / S	1.36	1.13	1.18	1.23	1.39	1.15	1.25	1.39	1.03	1.23	1.01	1.47	1.32	1.64	1.56	1.32	1.19	1.32	1.28	1.17
	P. O. C.	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
4.	Short arm (S)	1.98	2.09	1.98	1.89	1.68	1.79	1.69	1.51	1.72	1.52	1.68	1.34	1.40	1.20	1.25	1.36	1.39	1.30	1.30	1.35
	Long arm (L)	2.70	2.33	2.37	2.34	2.35	2.07	2.14	2.07	1.77	1.88	1.69	2.02	1.85	1.97	1.94	1.79	1.66	1.72	1.66	1.59
	Total length	4.68	4.42	4.35	4.23	4.03	3.86	3.83	3.58	3.49	3.40	3.37	3.36	3.25	3.17	3.19	3.15	3.05	3.02	2.96	2.94
	L / S	1.36	1.11	1.19	1.23	1.39	1.15	1.26	1.37	1.03	1.23	1.01	1.50	1.32	1.64	1.55	1.32	1.19	1.32	1.27	1.17
	P. O. C.	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
5.	Short arm (S)	1.97	2.08	1.98	1.90	1.67	1.78	1.70	1.53	1.71	1.53	1.68	1.35	1.39	1.21	1.23	1.36	1.40	1.31	1.30	1.35
	Long arm (L)	2.69	2.33	2.36	2.35	2.36	2.05	2.14	2.08	1.75	1.89	1.71	2.03	1.86	1.98	1.93	1.77	1.66	1.73	1.67	1.61
	Total length	4.66	4.41	4.34	4.25	4.03	3.83	3.84	3.61	3.46	3.42	3.39	3.38	3.25	3.19	3.16	3.13	3.06	3.04	2.97	2.96
	L / S	1.36	1.12	1.19	1.23	1.41	1.15	1.25	1.36	1.02	1.23	1.01	1.50	1.33	1.63	1.56	1.30	1.18	1.32	1.28	1.19
	P. O. C.	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m	m
	Mean length	4.68	4.42	4.34	4.23	4.03	3.84	3.83	3.60	3.46	3.40	3.39	3.37	3.25	3.19	3.17	3.13	3.07	3.02	2.98	2.95
	Standard error	0.006	0.003	0.006	0.007	0.005	0.006	0.005	0.006	0.008	0.007	0.007	0.003	0.004	0.007	0.007	0.007	0.006	0.007	0.009	0.004

Continued on next page

Table 6 (continued). Karyotype analysis of five different metaphases of *Rumex dentatus*.

Karyo-type	Parameters [µm]	Pair # 11		Pair # 12		Pair # 13		Pair # 14		Pair # 15		Pair # 16		Pair # 17		Pair # 18		Pair # 19		Pair # 20	
		21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
1.	Short arm (S)	1.08	1.23	1.20	1.08	1.32	1.15	1.26	0.94	1.20	1.19	1.10	1.02	1.09	1.00	1.11	0.90	0.97	1.05	1.02	0.78
	Long arm (L)	1.79	1.59	1.61	1.61	1.32	1.47	1.26	1.58	1.29	1.28	1.33	1.40	1.32	1.32	1.21	1.40	1.20	1.11	1.09	1.28
	Total length	2.87	2.82	2.81	2.69	2.64	2.62	2.52	2.52	2.49	2.47	2.43	2.42	2.41	2.32	2.32	2.30	2.17	2.16	2.11	2.06
	L / S	1.65	1.29	1.34	1.49	1.00	1.28	1.00	1.68	1.07	1.07	1.21	1.37	1.21	1.32	1.09	1.55	1.23	1.06	1.07	1.28
	P. O. C.	m	m	m	m	M	m	M	m	m	m	m	m	m	m	m	m	m	m	m	m
2.	Short arm (S)	1.09	1.24	1.22	1.09	1.30	1.14	1.26	0.95	1.20	1.18	1.10	1.01	1.10	1.01	1.11	0.89	0.96	1.04	1.00	0.77
	Long arm (L)	1.78	1.58	1.63	1.62	1.32	1.46	1.26	1.57	1.29	1.26	1.32	1.38	1.31	1.32	1.21	1.39	1.20	1.12	1.09	1.29
	Total length	2.87	2.82	2.85	2.71	2.64	2.60	2.52	2.52	2.49	2.44	2.42	2.39	2.41	2.33	2.32	2.28	2.16	2.16	2.09	2.06
	L / S	1.63	1.27	1.33	1.48	1.01	1.28	1.00	1.65	1.07	1.06	1.20	1.36	1.19	1.30	1.09	1.56	1.25	1.07	1.09	1.67
	P. O. C.	m	m	m	m	M	m	M	m	m	m	m	m	m	m	m	m	m	m	m	m
3.	Short arm (S)	1.07	1.24	1.19	1.07	1.32	1.16	1.24	0.93	1.21	1.18	1.09	1.00	1.09	1.00	1.10	0.90	0.97	1.03	1.02	0.78
	Long arm (L)	1.78	1.57	1.60	1.61	1.33	1.48	1.25	1.57	1.29	1.28	1.34	1.39	1.32	1.32	1.20	1.39	1.19	1.11	1.07	1.28
	Total length	2.85	2.81	2.79	2.68	2.65	2.64	2.49	2.50	2.50	2.46	2.43	2.39	2.41	2.32	2.30	2.29	2.16	2.14	2.09	2.06
	L / S	1.66	1.26	1.34	1.50	1.00	1.27	1.00	1.68	1.06	1.08	1.22	1.39	1.21	1.32	1.09	1.54	1.22	1.07	1.04	1.64
	P. O. C.	m	m	m	m	M	m	M	m	m	m	m	m	m	m	m	m	m	m	m	m
4.	Short arm (S)	1.10	1.22	1.20	1.08	1.32	1.15	1.26	0.92	1.20	1.17	1.10	1.02	1.08	1.01	1.10	0.91	0.97	1.06	1.01	0.78
	Long arm (L)	1.80	1.57	1.61	1.62	1.32	1.44	1.27	1.58	1.28	1.27	1.33	1.40	1.30	1.31	1.21	1.40	1.21	1.10	1.09	1.29
	Total length	2.90	2.79	2.81	2.70	2.64	2.59	2.57	2.50	2.48	2.44	2.43	2.42	2.38	2.32	2.31	2.31	2.18	2.16	2.10	2.07
	L / S	1.63	1.28	1.34	1.50	1.00	1.25	1.00	1.71	1.06	1.08	1.20	1.37	1.20	1.29	1.10	1.53	1.24	1.03	1.07	1.65
	P. O. C.	m	m	m	m	M	m	M	m	m	m	m	m	m	m	m	m	m	m	m	m
5.	Short arm (S)	1.08	1.23	1.21	1.09	1.31	1.13	1.26	0.93	1.21	1.19	1.11	1.00	1.08	1.01	1.11	0.90	0.96	1.01	1.02	0.79
	Long arm (L)	1.78	1.59	1.62	1.62	1.31	1.44	1.26	1.58	1.27	1.28	1.32	1.39	1.31	1.30	1.22	1.40	1.19	1.09	1.08	1.29
	Total length	2.86	2.82	2.83	2.71	2.62	2.57	2.52	2.51	2.48	2.47	2.43	2.39	2.39	2.31	2.33	2.30	2.15	2.10	2.10	2.08
	L / S	1.64	1.29	1.33	1.48	1.00	1.27	1.00	1.69	1.04	1.07	1.18	1.39	1.21	1.28	1.09	1.55	1.23	1.07	1.05	1.63
	P. O. C.	m	m	m	m	M	m	M	m	m	m	m	m	m	m	m	m	m	m	m	m
	Mean length	2.87	2.81	2.82	2.70	2.64	2.60	2.52	2.51	2.49	2.46	2.43	2.40	2.40	2.32	2.32	2.30	2.16	2.14	2.10	2.07
	Standard error	0.008	0.006	0.01	0.006	0.005	0.012	0.013	0.005	0.004	0.007	0.002	0.007	0.006	0.003	0.005	0.005	0.005	0.012	0.004	0.004

Total chromosome length: 120.5 µm; Range of mean length of individual chromosomes: 4.7-2.0 µm

Karyotype formula: 2n=40 = C5 + F13 + I22