

Chromosomal Studies on Some Plants in the Flora of Madinah Region

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ABSTRACT. Cytological investigations on some plants in the flora of Madinah region revealed the following chromosome counts in the following eight species. *Asphodelus fistulosus* $2n = 28$, *Astragalus eremophilus* $2n = 16$, *Erodium oxyrhynchum* $2n = 18$, *Iris postii* $2n = 14$, *Plantago arabica* $2n = 12$, *Plantago cylindrica* $2n = 10$, *Rumex vesicarius* $2n = 18$, and *Schouwia thebaica* $2n = 24$. The first three species and the last one, i.e. *S. thebaica* have short chromosomes mean length less than $2 \mu\text{m}$. *I. postii*, *P. arabica* and *R. vesicarius* have a mean chromosome length of more than $4 \mu\text{m}$. The karyotype of *I. postii* is highly asymmetric with evident variation in length among the chromosome. However, the karyotypes of the other taxa are symmetric. No polyploidy is reported in the examined species. The karyotypes of the examined species are described for the first time in plants from Saudi Arabian flora.

Introduction

The fact that chromosomes are the carriers of genetic information provided an impetus for their studies since the establishment of the chromosomal theory of inheritance in the second decade of this century. The steady increased amount of information on chromosomes and the development of cytogenetic concepts and methods demonstrated the importance of chromosomes in several fields of plant biology. In the field of plant systematics and flora, the spectacular rise in the publication of reliable chromosome data in the past 25 years began to make clear the cytogenetic mechanisms involved in the evolution and delimitation of plant taxa and the variety

of ways these mechanisms are expressed in the great diversity of plants comprising the World flora. Chromosomal features are being regarded as decision making characters in the study of phylogenetic affinities and evolutionary development, and as indicators of appropriate classifications of several plant groups^[1].

Chromosomal information have also been used in the study of floras particularly those regarding chromosome number because it is the easiest to assess. Chromosome numbers indicate the occurrence of polyploidy and reflect differences in the basic chromosome numbers among plants which may be reflected in their treatments in floras. It is estimated that over 3000 chromosome counts are annually recorded every year. However, chromosome numbers are only known for 15-20% of angiosperm species^[2]. Other karyotype features, such as chromosome size, position of centromere and the presence of satellites in chromosomes of the karyotype are recorded in less than 1% of angiosperms. More detailed karyotype characters, such as the disposition of heterochromatic segments, revealed by banding techniques, are very poorly known.

There is a great regional imbalance in the chromosomal information of the floras in different parts of the World. In general, chromosome numbers are known for a much greater proportion of temperate than tropical and desert floras, although much work is to be done on the chromosomes of temperate floras. In the flora of Europe, which is one of the best studied in the World chromosome numbers are recorded for about 36% of angiosperms excluding monocotyledons^[2]. Chromosomal information on the plants of other parts of the World, particularly those of desert and tropical floras, is sparse. Consequently, the chromosome features in these floras are poorly understood. No chromosome counts have been reported for wild plants of Saudi Arabia. In this study, we report, for the first time, the chromosome number of karyotype structure of some plants in the flora of Madinah region. We hope that this will encourage others to start studies on the chromosomes of plants in the flora of Saudi Arabia.

Material and Methods

Specimens of more than 50 plants collected from different localities in the study area. Collected plants were identified and classified following Migahid^[3] and Colenette^[4]. Seeds of a number of plant species were obtained and germinated on moist filter paper in petri dishes at a temperature ranging between 20-30°C, but germination did not take place for two weeks. However, after treatment with a solution of 100 ppm gibberillic acid for at least 48 hours, a satisfactory percentage of seed germination of most species took place.

Germinating root tips were used for the study of chromosomes. Cytological preparations of the root tips were made using Feulgen squash technique. Growing root tips were pre-treated with a solution of 0.05% colchicine in order to arrest mitosis at metaphase and make chromosomes short and scattered to facilitate their study. Root tips were then fixed in a fresh solution of 3:1 ethanol-glacial acetic acid for 24 hours and kept in 70% ethanol until use for cytological preparations.

Cytological preparations were carried out using Feulgen squash technique following the method described by Darlington and La Cour^[5]. The applied method is as follows: Root tips were hydrolysed in 1N HCl for 8-10 minutes, washed in distilled water and stained in leucobasic fushin for 2 hours. Squash preparations of root tips were made in few drops of 45% acetic acid between a clean glass and cover lip. Cover slips were separated in absolute alcohol and preparations were made permanent by mounting in Euparal. Leucobasic fuchsin was prepared as follows :

1. Dissolve 1 gm of basic fuchsin by pouring over it 200 ml of boiling distilled water.
2. Leave the solution to cool to about 50°C and add 3 gm of potassium metabisulphite and 30 ml of 1N HCl. Shake well and leave in a tightly closed dark bottle in the dark overnight.
3. Add 1-2 gm of activated charcoal, shake well and filter, the filterate is the leucobasic fuchsin. It should be as clear as water. Keep in a refrigerator until use.

Permanent cytological preparations of some species were examined using a Karl Zeiss microscope. Cells of good chromosome spreading were photographed with an automatic camera. Photographic prints were enlarged to a magnification of 4000. Chromosome number and mean chromosome length for each species were made from these prints. In some species, it was reliably possible to locate centromere position on chromosomes. For these species, the mean arm ratio of the karyotype was calculated. Karyotype morphology for each species was then described on the bases of chromosome measurements.

Results and Discussion

Germination of seeds of almost all the eight plants did not take place in water for two weeks. Only seeds of *Asphodelus fistulosus* germinated during this period. Seeds were, therefore, treated with 100 ppm solution of gibberillic acid to enhance their germination. Germinating seeds were then transferred onto moist filter paper. The percentage of seed germination before and after gibberillic acid treatment is given in Table 1. The highest proportion of seed germination was recorded in *Plantago cylindrica* (86.9%), where the lowest was observed in *Schouwia thebaica* (5.3%). A high percentage of germination was also scored in *Iris postii* (75.0%). The percentage of seed gemination in other species was less than 50.

Morphology and Distribution of the Cytologically Studied Species

1. *Asphodelus fistulosus* L. (*A. tenuifolius* Cav.)

Annual herb with dense basal leaf rosette and many sometimes branching scape. Leaves semiterete, keeled on the lower surface scabrous tapering towards the tip and much shorter than the scape. Flowers in panicle at the top of scape or scape branches. Perianth segments white usually with a coloured band on the back of segments. Fruit a globose capsule 3-4 mm in diameter, seeds winged back. A very common plant not only in Madinah region but elsewhere in the Kingdom of Saudi Arabia. It flourishes in sandy and loamy fields, valleys and sandy and rocky deserts. Less common at high

TABLE 1. Percentage of seed germination of some plant species from Madinah region without and with gibberillic acid treatment.

Species	Family	% of germination without gibberillic acid treatment	% of germination after gibberillic acid treatment
<i>Asphodelus fistulosus</i>	Liliaceae	34.9	37.2
<i>Astragalus eremophilus</i>	Leguminosae	0.0	36.8
<i>Erodium laciniatum</i>	Geraniaceae	0.0	35.0
<i>Iris postii</i>	Iridaceae	0.0	75.0
<i>Plantago cylindrica</i>	Plantaginaceae	21.7	86.9
<i>Plantago arabica</i>	Plantaginaceae	0.0	47.4
<i>Rumex vesicarius</i>	Polygonaceae	16.5	34.4
<i>Schouwia thebaica</i>	Cruciferae	0.0	5.3

altitudes. The examined material was collected from Al-Suwaidra about 70 km East of Madinah.

2. *Astragalus eremophilus* Bioss

Grey prostrate annual herb covered all-over with spreading hairs. Stem about 10 cm long. Leaves compound, pinnate with 3-6 pairs of entire, obovate, retuse 4-8 mm long leaflets. Flowers papilionate in small racemes each with 2-5 loose flowers. Petals pale sulphur-yellow, standard slightly longer than keel. Fruit a 2-5 cm long villous legume, flattened, slightly falcate to semi-circular, narrow, acute 8-10 times as long as broad with upper margins inflexed making the inner space 2-roomed. Seeds – 8 per legume, ovoid, brown in colour. Of rare occurrence in the deserts and dry places but of fair occurrence at high altitudes. The examined material was collected from Wadi Hazrah, about 45 km West of Madinah.

3. *Erodium oxycorrhynchum* M. Biel

Annual leafy herb up to 25 cm high. Leave simple, petiolate, entire, cordate, trilobed or triparted below. Flowers small, pentamerous, regular with narrow rose-coloured 6 mm long petals. Beak up to 10 cm long. Fruit a capsule splitting at maturity, lacking central column. Seeds brown. Of rare occurrence in dry places but of moderate occurrences in wadis and at high altitudes. The examined material was collected from Al-Figra in the mountains west of Madinah, at about 1500 m above sea level

4. *Iris postii* Nouterde

Herbaceous prennial herb with ovate or globose bulb wrapped in brown coarsely fibrous coats. Leaves few up to 20 cm long, often keeled and prominently nerved. Scape as long as leave or shorter. Flowers solitary often terminating a scape, but sometimes in pairs, 3-4 cm long, purple to blue in colour. Perianth segments united below forming a tube longer than ovary. Fruit a capsule, seeds black. First recorded in Saudi Arabia by Collenette^[4] who stated that it is distributed in small scattered groups. The examined material was collected from Al-Figra at an altitude of 1600 m.

5. *Plantago arabica* Boiss. (*P. afra* L.)

Annual or prennial erect shrublet which unlike other *Plantago* species is richly branched. Leaves opposite up to 10 cm long and 1.5 cm wide, petiolate, linear with entire margin and obtuse tip. Stem 2-6 in number up to 10 cm long. Flowers small in compact 8-20 cm long spikes, borne on opposite peduncles. Sepals ovate, obtuse with greenish nerve. Petals slightly longer than sepals, ovate acute yellowish with a dark brown nerve. Ovary ovate, 2-loculed. Seeds 3-4 times as long as broad, brown in colour. This species is recorded in Saudi Arabia as *P. afra* L. However, the examined material is more similar to *P. arabica*. It is of rare occurrence in the study area but has been recorded in 2 localities. The material examined was collected from Al-Suwaidra, 70 km East of Madinah.

6. *Plantago cylindrica* Forssk.

Annual or prennial stemless scapose herb. Leaves five-many petiolate, lanceolate to linear, entire with acute tip and tapering towards the petiole. Scape up to 20 cm, terete covered with minute hairs and terminated with flowers in 2-10 cm long spike. Flowers small. Sepals 4, united oblong, obtuse, white with green nerve. Petals as long as sepals, lanceolate, acute, pale yellow with brown nerve. Stamens much longer than petals and carry large anthers. Ovary 2-loculed, ovate. Fruit a capsule, seeds cymbiform to elliptical, light brown with large brown spot on the dorsal side. Of common distribution in desert. The examined material was collected from Al-Khulail in the vicinity of North-West Madinah.

7. *Rumex vesicarius* L. (*Acetosa vesicaria* (L.) Love)

Annual greeny, leafy glabrous branched herb up to 20 cm long. Leaves fleshy, ocate-triangular, obtuse, subcordate or subhastate at the base. Flowers bright red in terminal simple raceme or panicle. Every 1-3 flowers are attached to one pedicel supported by a bract. Sepals wide, enlarging to enclose the fruit. Fruit forming scarious reticulate wings. Seeds small triangular. Of wide distribution in several habitats in the Kingdom. The examined material was collected from Al-Suwaidra.

8. *Schouwia thebaica* Webb. (*S. purpuria* (Forsak.) Schweinf.
V. schimperi Muschl. and *S. schimperi* Jaub.)

Tall stout glabrous annual plant up to 6 cm high, with simple, broad fleshy leaves. Radical leaves oblong, entire, tapering at the base; cauline leaves ovate, acute, deeply cordate auricled. Flowers deep rose tetramerous. Fruit an almost flat, round pod with two locules. Seed light brown. Of rare occurrence in desert. The examined sample was collected from Wadi Al-Agoul in the vicinity of North-East Madinah.

Chromosome Characters of the Cytologically Studied Species

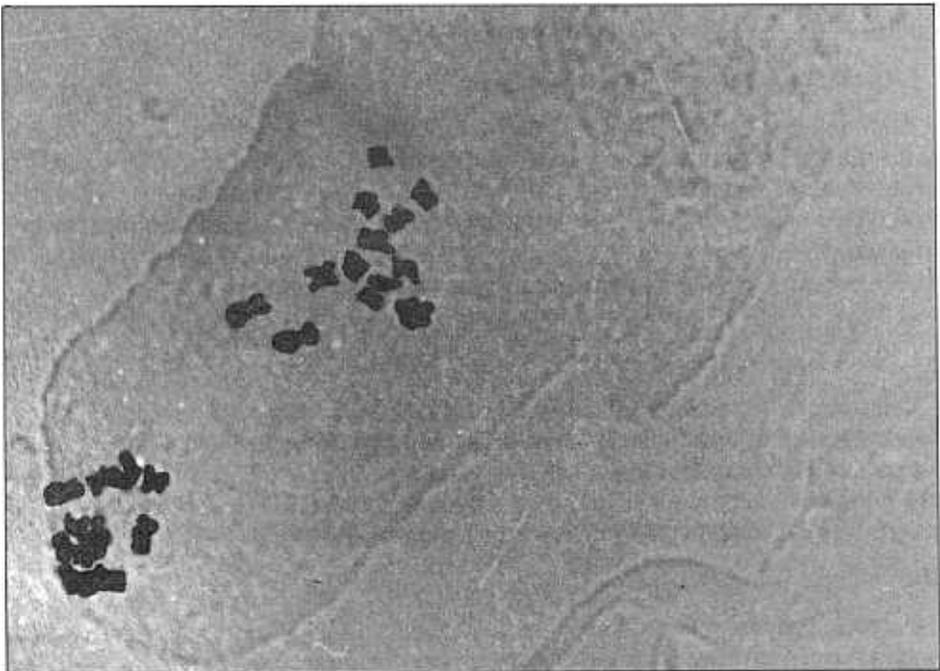
Chromosome numbers and mean chromosome length of the 8 cytologically investigated species are given in Table 2. Karyotypes of these species are illustrated in Fig. 1-8. The main chromosome characters of these 8 species are described here and compared with previous studies on their cytology.

TABLE 2. Chromosome number and mean chromosome length of the cytologically studied plant species from Madinah region.

Species	Chromosome number (2n)	Mean chromosome length (μm)
<i>Asphodelus fistulosus</i>	28	1.38
<i>Astragalus eremophilus</i>	16	1.54
<i>Erodium oxyrrhynchum</i>	18	1.68
<i>Iris postii</i>	14	4.22
<i>Plantago arabica</i>	12	4.01
<i>Plantago cylindrica</i>	10	2.88
<i>Rumex vesicarius</i>	18	4.61
<i>Schouwia thebaica</i>	24	0.92

1. *Asphodelus fistulosus*

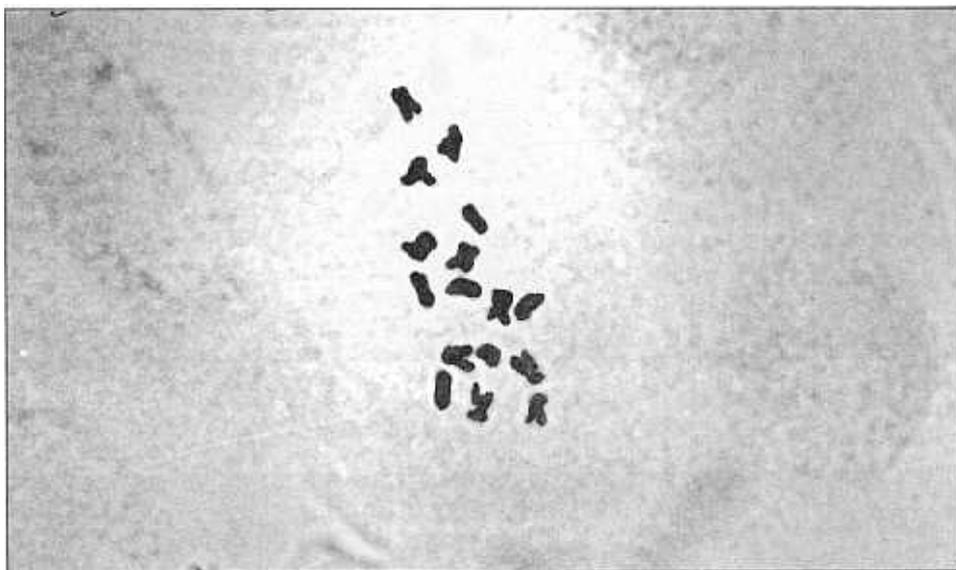
A diploid chromosome number of $2n = 28$ was recorded in this species. The karyotype (Fig. 1) is comprised of small metacentric and submetacentric chromosomes (mean length = $1.38 \mu\text{m}$) with a small variation among the chromosomes. The number recorded here resembles that of *A. fistulosus* from Egypt^[6] and from the Balearic Islands^[7]. However, the karyotype of *A. fistulosus* is described here for the first time. Bjorkovist *et al.*^[8] had reported a polyploid chromosome number of $2n = 56$ in plants of this species from Iberia.



Asphodelus fistulosus $2n = 28$

2. *Astragalus eremophilus*

The chromosome number recorded in this species in $2n = 16$. No previous counts are known for *A. eremophilus*, but the recorded number resembles other numbers reported in several species of *Astragalus* from different parts of the World^[9]. The karyotype of this species is composed of metacentric to submetacentric chromosomes with little variation in length. The chromosomes of this species are also very short (mean length = $1.54 \mu\text{m}$).



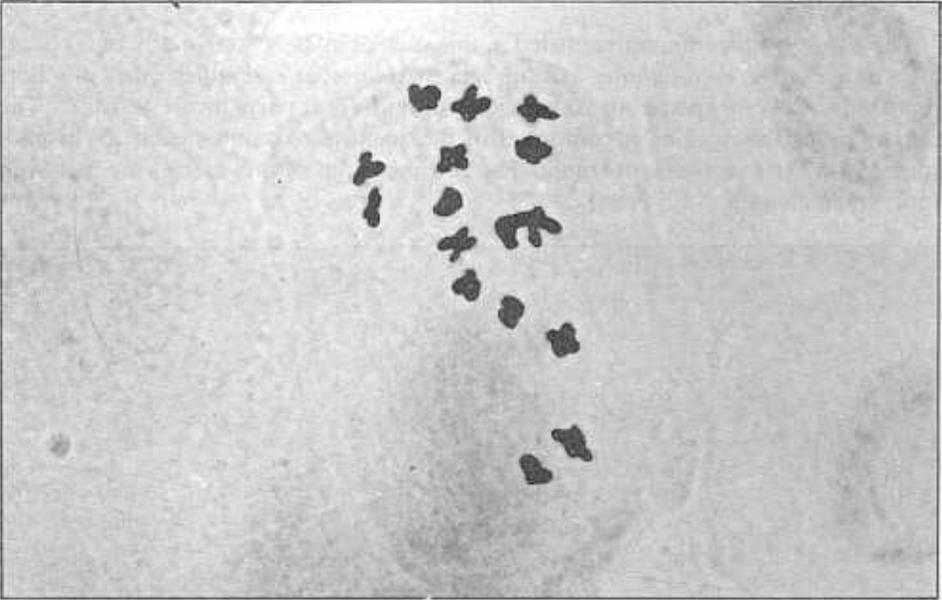
2. *Astragalus eremophilus* $2n = 16$

3. *Erodium oxyrrhynchum*

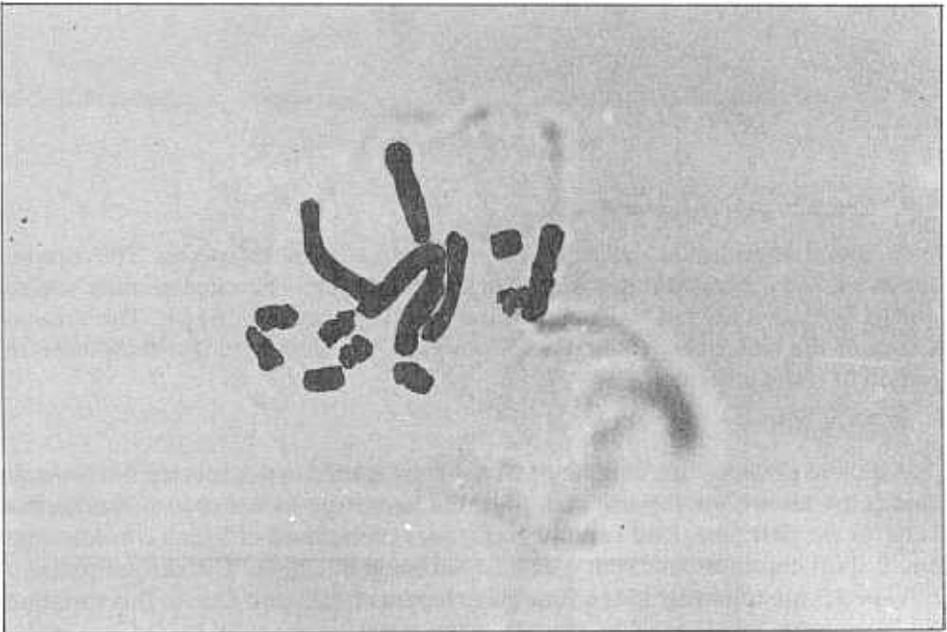
A diploid chromosome number of $2n = 18$ is recorded in this species. The chromosomes are very short having a mean length of $1.68 \mu\text{m}$. The same number was reported by Badr and Hamoud^[6] in material of this species from Egypt. The chromosomes of the material examined here, however, are slightly longer than those reported by those authors.

4. *Iris postii*

A diploid chromosome number of $2n = 14$ is recorded in this species. No previous counts are known for *I. postii* and, thus, the karyotype of this species is described here for the first time. The karyotype (Fig. 4) is comprised of 6 long chromosomes and 8 short chromosomes with a distinct variation in length. The chromosomes of this species are relatively long with a mean length of $4.22 \mu\text{m}$. Due to this variation, the karyotype of *I. postii* is highly asymmetric compared to the symmetric karyotypes observed in the other examined species.



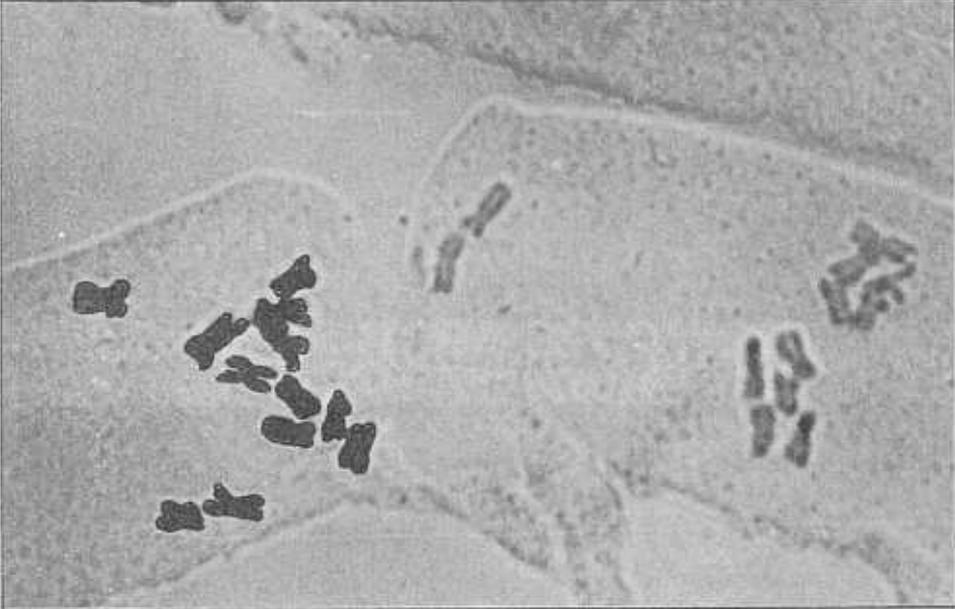
3. *Erodium oxycorymbium*



4. *Iris postii*

5. *Plantago arabica*

A diploid chromosome number of $2n = 12$ is recorded in this species. The same number was reported in material from Egypt by Badr and El-Kholy^[10] who described the karyotype of *P. arabica* for the first time. The karyotype described by these authors is similar to the one observed here. The karyotype (Fig. 5) is comprised of metacentric and submetacentric chromosomes with a slight variation in length among the karyotype. The chromosomes of this species are relatively longer than those of *P. cylindrica*, mean length being $4.01 \mu\text{m}$.



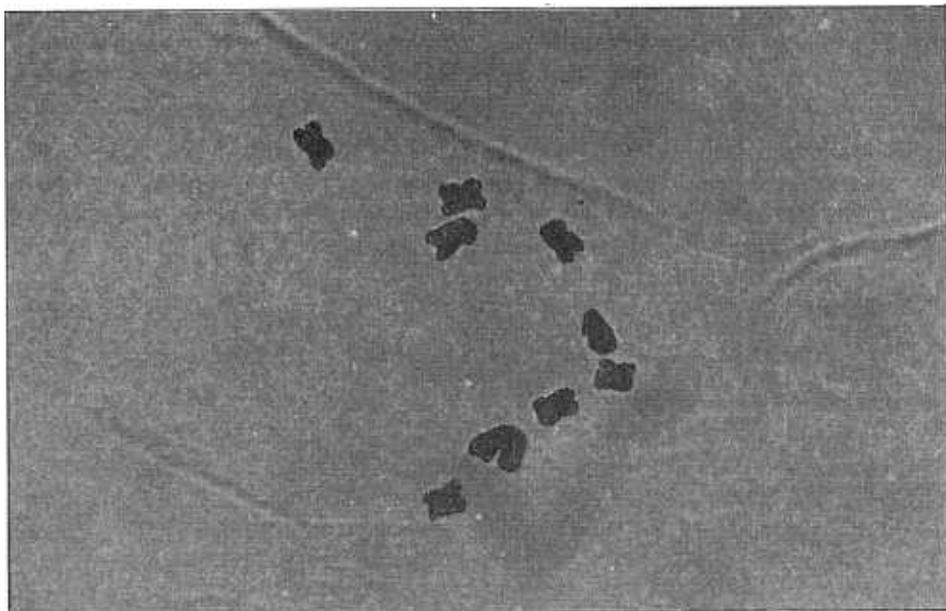
5. *Plantago arabica* $2n = 12$

6. *Plantago cylindrica*

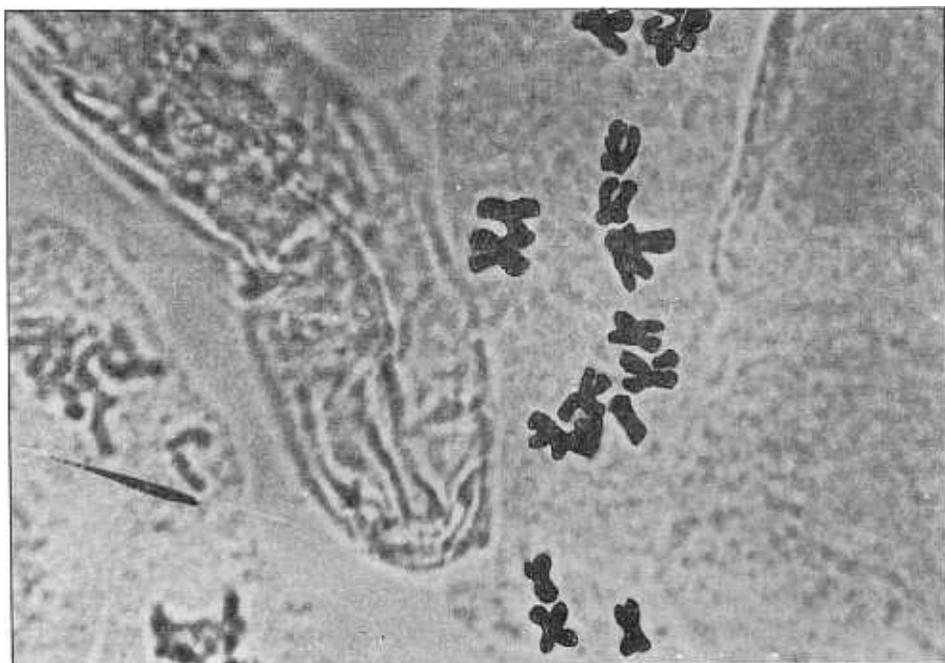
A diploid chromosome number of $2n = 10$ is recorded in this species. The karyotype (Fig. 6) is symmetric showing small variation in length and centromere position. All chromosomes being metacentric and submetacentric with a mean length of $2.88 \mu\text{m}$. The karyotype of the examined material resemble that described for this species by Badr and El-Kholy^[10] for material from the Egyptian flora. No other chromosome counts are known for *P. cylindrica*.

7. *Rumex vesicarius*

A diploid chromosome number of $2n = 18$ is recorded in this species. No previous counts are known for *R. vesicarius*. The mean chromosome length is $4.61 \mu\text{m}$. The karyotype (Fig. 7) is composed of metacentric-submetacentric with little variation in length among chromosomes.



6. *Plantago cylindrica* $2n = 10$

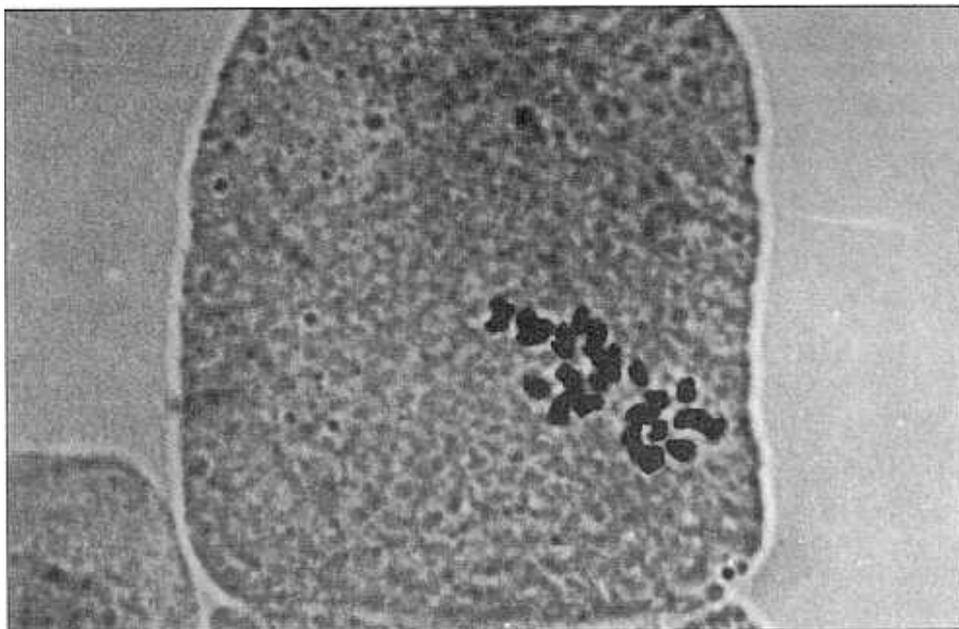


7. *Rumex vesicarius* $2n = 18$

8. *Schouwia thebaica*

A chromosome number of $2n = 24$ is recorded in this species. The chromosomes are extremely short with a mean length of only $0.92 \mu\text{m}$. The chromosomes of *S. thebaica* are described for the first time here.

It is to be noted that no polyploid chromosome numbers are recorded in the studied plants from the Madinah region. However, since the present chromosome counts are reported for the first time in plants of the Saudi Arabian flora, it is unwise to make conclusions. Much more work on the chromosomes of Saudi Arabian plants is needed.



8. *Schouwia thebaica* $2n = 24$

Acknowledgement

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دراسات كروموسومية على بعض النباتات من فلورة منطقة المدينة المنورة

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المدينة المنورة ، المملكة العربية السعودية

المستخلص . أوضحت الدراسات السيتولوجية على ثمانية أنواع نباتية من فلورة منطقة المدينة المنورة أن الأنواع التالية بها العدد الكروموسومي قرين كل منها :

Asphodelus fistulosus	ن٢ = ١٨	البروق
Astragals eremophilus	ن٢ = ١٦	القفعاء
Erodium oxyrrhynchum	ن٢ = ١٨	المرغط
Iris psotii	ن٢ = ١٤	العنصلان
Plantago arabica	ن٢ = ١٢	الخزامي
Plantago cylindrica	ن٢ = ١٠	أم لبيدة
Rumex vesicarius	ن٢ = ١٨	الحميض
Schouwia thebaica	ن٢ = ٢٤	الخزامي

وتتميز الثلاثة أنواع الأولى (البروق والقفعاء والمرغط) والنوع الأخير (الخزامي) بكروموسومات قصيرة متوسط طولها يقل عن ٢ ميكرومتر ، في حين يتميز العنصلان والخزام والحميض بكروموسومات طويلة نسبياً ، إذ يزيد متوسط طول الكروموسوم بها على ٤ ميكرومتر . وتتباين كروموسومات العنصلان في أطوالها مما يجعل كاريوتيب هذا النوع غير متوازن . أما الأنواع الأخرى فتشابه كروموسوماتها في الطول وفي موضع السترومير بها مما يجعلها متوازنة . وتجدر الإشارة إلى أن النباتات التي أجريت الدراسة عليها لم يسجل بها أعداد كروموسومية متضاعفة . وقد تم وصف التركيب الكروموسومي لهذه الأنواع لأول مرة في نباتات من فلورة المملكة العربية السعودية .