Determination of chromosome numbers in Kuwaiti flora II

GHANIMA MALALLAH¹, MODI AL-DOSARI¹ & AUGUSTÍN MURÍN²

¹Department of Biological Sciences, Faculty of Science, Kuwait University, P.O. Box 5969, Code no. 13060, Kuwait
²Department of Botany, Faculty of Science, Comenius University, Révova 39, 81102, Bratislava, Slovakia

ABSTRACT: This paper deals with the somatic (sporophytic) and gametic chromosome numbers of some indigenous wild species of Kuwaiti flora. All samples were collected from the wild. Some values are reported for the first time such as Aaronsohnia factorovskyi, 2n=18 and n=9, Carduus pycnocephalus, 2n=26 and n=13, Centaurea bruguierana 2n=16, Rhanterium epapposum, 2n=12 and n=6, Horwoodia dicksoniae, 2n=26, Bassia muricata, n=9, Alhagi graecorum, 2n=16, Salvia spinosa, n=10, Rumex vesicarius, n=9, Lycium shawii, n=12 and Nitraria retusa, n=12.

KEYWORDS: chromosome numbers, meiosis, flowering plants, Kuwait.

Introduction

& Murín 1987; Rao & Chandel 1991; Murín & al. 1999). On the basis of such information it has often been possible to interpret the genetic interrelationships existing within species (Berdahe & Barker 1991; Brochmann 1992; Štepánková 1993).

This paper is a continuation of our karyological research on Kuwaiti flora (Malallah & al. 1996, 1997; Malallah & Brown 1999) and the plant species reported here are the second sample in the investigation.

Materials and methods

26 species from 10 different families were examined for chromosome number. The families and the species examined are shown in Table.1. The nomenclature and synonyms are in accordance with Daoud (1985), Al-Rawi (1987), and Boulos & Al-Dosari (1994). The selection of the species was made according to the most well prepared and spread sample.

Seeds and buds were collected from at least three different plants growing at various localities in Kuwait. The seeds were germinated in a controlled growth chamber at 16°C on moist filter paper enclosed in Petri dish. Actively growing root tips were pretreated either with 0.05% colchicine for 4h or with 20h cold water at 5°C in order to have C-metaphases and then fixed in Carnoy’s fixative (1:3 glacial acetic acid alcohol) until use. For slide preparation, the excised root tips were washed with distilled water for 4-5 min., hydrolyzed in 1N hydrochloric acid for 10-12 min. at 60°C and finally rinsed with distilled water for 4-5 min. Young buds were kept in Carnoy’s fixative till use. The anthers or root tips were squashed in a drop of 1-% aceto-carmine stain and covered with a clean cover glass. Microscopic analysis was carried out with an Olympus BH-2 photomicroscope. Micrographs were taken when necessary at 1000X magnification from temporary preparation. Several well-spread metaphases were counted to confirm the validity of the chromosome number.

Results and discussion

Due to the low annual rainfall, shortage of water, grazing animals and many other factors, the wild vegetation in Kuwait was observed to be very poor particularly the period of 1992-2000. During the time of 1997-1999 (the period of the present study), many species were hardly seen in many localities. The observation on the scarly vegetation was reported in a study extended two periods: 1974-1978 and 1987-1990 (Halwagy & El-Saadawi 1992). In the first period around 133 species of annuals and biennials and 26 species of perennials were recorded. In the second period only 16 and 12, respectively were observed. The authors explained that the reduction in the number of plant species, annuals and perennials, was due mainly to successive years of drought. Because of the poor vegetation, it was difficult to obtain many plant species (as flower buds or seeds or mature plant) in adequate amount for the present research studies.
According to this situation, and to preserve the diversity of indigenous plant species we felt that it is very important to involve part of the present work (not included) in preservation of some endangered Kuwaiti plant species. In this text, data obtained in present work (starting with *) are compared with the relevant data from literature in individual style for each species.

**Asteraceae (Compositae)**

*Aaronsohnia factorovsksyi* WARD & EIG

Kuwaiti data: It is an annual herb that grows in sandy and loamy soil. There are only individual plants scattered in many localities. The flowering time is March-April.

* 2n = 18  n = 9

**Literature data and comments:**

No data available for this species in the published Indexes to Plant Chromosome Numbers-Missouri Botanical Garden (IPCN) or elsewhere. However, one reference showed that the another species of the same genus, *A. pubescens* (DESF.) BREMER & HUMPHRIES have somatic number of 18 (VOGT & OBERPRIELER 1993, sec. GOLDBLATT & JOHNSON 1996), demonstrating the probability that the basic number for this genus is 9. The somatic and gametic numbers of the Kuwaiti species are the first to be reported. Fig. 1 shows several events during meiosis demonstrating the behavior of the bivalents. In the cells, there are nine bivalents (Fig. 1 B), three of which are with two chiasmata, one in each arm and thus forming three ring bivalents and the rest of the bivalents has one terminal chiasma forming six rods. The chiasmata are terminalized one by one (Fig. 2 A & B).

*Carduus pycnocephalus* L.

**Syn.:** *C. tenuiflorus* CURT var. *pycnocephalus* (L.) DC.

Kuwaiti data: It is a common annual herb that is found in dry sandy soil in many places. The flowering time is April-May.

* 2n = 26  n = 13

**Literature data and comments:**

interesting to notice that this species with the synonym *C. tenuiflorus* CURT was treated as different species and was shown with 2n=54 (MORTON 1977, sec. GOLDBLATT 1981; DEVES 1981, sec. GOLDBLATT 1984; PAJARON SOTOMAYOR 1982, sec. GOLDBLATT 1985) and n = 27 (DEVES 1981, sec. GOLDBLATT 1984; MATHEW & MATHEW 1988, sec. GOLDBLATT & JOHNSON 1991). With the new somatic and gametic values from Kuwaiti flora, it is important to clarify whether we are dealing with one or two different species.

**Carthamus oxyacantha** M. BIEB.

Kuwaiti data: It is a common annual herb that grows in sandy soil and flowers during April-July.

* 2n = 24
  n = 12

Literature data and comments:

**Centaurea bruguierana** (DC.) HAND.-MAZZ.

Syn.: *C. phyllocephala* BOISS.

Kuwaiti data: It is an annual herb that grows in sandy soil. Many plants were found only in one locality (Al-Salmi - Kuwait border with S. Arabia). The flowering time is April-May.

* 2n = 16
  n = ?

Literature data and comments:
This somatic value 16 is another different value for this species. The other values were 2n = 20 (GHAFFARI 1984, sec. GOLDBLATT 1988) and 2n=22 (MOORE 1973) This could reflect the role of geographical distribution of the species. One reference showed that n=10 (GHAFFARI & al. 1989, sec. GOLDBLATT & JOHNSON 1991).

**Rhanterium epapposum** OLIV.

Kuwaiti data: aromatic perennial subshrub that grows commonly in many areas.
The flowering time is February-July.

* 2n = 12
  n = 6

Literature data and comments:
This species has no reported chromosomal counts. The gametic and somatic chromosome numbers in this investigation are the first to be reported. Fig. 3 shows the twelve chromosomes of this species for the first time.
Fig. 1. *Aaronsohnia factorovskyi*, showing events during meiosis; A – the nine bivalents, B – 3 ring- and 6 rod-bivalents.

Fig. 2. A&B – showing the process of terminalization of the chiasmata in *Aaronsohnia factorovskyi*.

Fig. 3. A cell of *Rhanterium epapposum* shows the 12 chromosomes.
Table 1. Families and species studied in this work and their chromosome numbers.

<table>
<thead>
<tr>
<th>Family</th>
<th>Species</th>
<th>Gametic no.</th>
<th>Somatic no.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Asteraceae</td>
<td>Aaronsonia factorovskyi</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Carduus pycnocephalus</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Carthamus oxyacantha</td>
<td>12</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td>Centaurea bruguierana</td>
<td>–</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Rhanterium epapposum</td>
<td>6</td>
<td>12</td>
</tr>
<tr>
<td>Brassicaceae</td>
<td>Brassica tournefortii</td>
<td>10</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Cakile arabica</td>
<td>9</td>
<td>–</td>
</tr>
<tr>
<td></td>
<td>Horwoodia dicksoniae</td>
<td>13</td>
<td>26</td>
</tr>
<tr>
<td></td>
<td>Schimpera arabica</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Sisymbrium irio</td>
<td>14</td>
<td>–</td>
</tr>
<tr>
<td>Chenopodiaceae</td>
<td>Bassia enophora</td>
<td>–</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Bassia muricata</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td></td>
<td>Chenopodium murale</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Fabaceae</td>
<td>Alhagi graecorum</td>
<td>–</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Hippocrepis areolata</td>
<td>7</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Medicago rotata</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Trigonella anguina</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Trigonella hamosa</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Trigonella stellata</td>
<td>8</td>
<td>16</td>
</tr>
<tr>
<td>Geraniaceae</td>
<td>Erodium laciniatum</td>
<td>–</td>
<td>20</td>
</tr>
<tr>
<td>Iridaceae</td>
<td>Gynandriris sisyrinchium</td>
<td>–</td>
<td>24</td>
</tr>
<tr>
<td>Lamiaceae</td>
<td>Salvia spinosa</td>
<td>10</td>
<td>–</td>
</tr>
<tr>
<td>Polygonaceae</td>
<td>Emex spinosa</td>
<td>–</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td>Rumex vesicarius</td>
<td>9</td>
<td>18</td>
</tr>
<tr>
<td>Solanaceae</td>
<td>Lycium shawii</td>
<td>12</td>
<td>–</td>
</tr>
<tr>
<td>Zygophyllaceae</td>
<td>Nitraria retusa</td>
<td>12</td>
<td>–</td>
</tr>
</tbody>
</table>

**Brassicaceae (Cruciferae)**

*Brassica tournefortii* GOUAN

Syn.: *B. sisyembrinoides* (FISCHER) GROSSH., *Erucastrum minutillorum* PAU & FONT QUER., *Sinapis caspica* WILD. ex LEDEB.

Kuwaiti data: it is a common annual herb that grows in sandy soil in many places.

* 2n = 20  
  n = 10

Literature data and comments:
The somatic count of this species was shown to be 2n = 20 (2 ref. in BOLKHOVSKIKH & al. 1969; COLOMBO & al 1983, sec. GOLDBLATT & JOHNSON
1990) and Kuwaiti data are consistent with reported values. The gametic value here is also consistent with the other values (2 ref. in MOORE 1974).

*Cakile arabica* VELEN. & BORN.
Kuwaiti data: It is common annual herb that grows in sandy and sand dunes. Flowering time is February-March.
* 2n = ? n = 9
Literature data and comments:
The gametic value of the Kuwaiti species is consistent with other values (RODMAN & BHARGAVA 1976, RODMAN 1978, sec. GOLDBLATT 1981; AL-SHEHBAZ 1978, sec. GOLDBLATT & JOHNSON 1990). The somatic count has not been recorded yet.

*Horwoodia dicksoniae* TURRILL
Syn.: *Malcolmia musili* VEL.
Kuwaiti data: It is an annual herb that is found in sandy soil. This species is extinct because just two individual plants were seen in the 1999-2000. DAoud (1985) mentioned that this species is distributed in many places, but in 1998 only one sample was found and we took the seeds from it to determine the chromosome number.
* 2n = 26 n = 13
Literature data and comments:
This is the first time to report the somatic number of this species. The gametic number was found to be n = 13 (RODMAN 1978, sec. GOLDBLATT 1981; AL-SHEHBAZ 1978, sec. GOLDBLATT & JOHNSON 1990), and the Kuwaiti values is the third to be reported.

*Schimpera arabica* HOCHST. & STEUD.
Kuwaiti data: it is annual herb that grows commonly in sandy soil. The flowering time is February-March.
* 2n =14 n = 7
Literature data and comments:
The gametic chromosome number for this species in this study is consistent with other values where n = 7 (AL-SHEHBAZ & AL-OMAR 1982, 1983, sec. GOLDBLATT 1985). Only one reference showed that 2n = 14 (KLIPHUIS & BARKOUDAH 1977, sec. GOLDBLATT 1981) and the Kuwaiti value is the same and the second to be reported.

*Sisymbrium irio* L.
Syn.: *S. austriacum* JACQ. subsp. *multisiliquosum* (HOFFM.) ROUY & FOUC., *S. multisiliquosum* HOFFM.
Kuwaiti data: It is an annual herb that distributed in many places in hard sandy soil. Flowering time: March-April.

143
* 2n = ?   n = 14

Literature data and comments:

Chenopodiaceae

*Bassia eriophora* (SCHRAD.) ASCHERS.
Syn.: *Kochia eriophora* SCHRAD.; *K. latifolia* FRESEN.
Kuwaiti data: it is a common annual herb, which is found in sandy soil in many places.
* 2n = 18   n = ?

Literature data and comments:
For this species, 2n =18 (WULF 1963, sec. BOLKHOVSKIKH & al. 1969 and MOORE 1973). The gametic count is to be detected.

*Bassia muricata* (L.) ASCHERS.
Syn.: *Salsola muricata* L.; *Kochia muricata* (L.) SCHRAD.
Kuwaiti data: It is an uncommon annual herb, which found in sandy soil in many places. The flowering time: March-April.
* 2n = 18   n = 9

Literature data and comments:
The somatic value for this species is the second to be reported. The first value was reported in one reference (REESE 1957, sec. BOLKHOVSKIKH & al. 1969). The gametic number for this species is the first to be reported from Kuwaiti flora showing that the basic number is 9.

*Chenopodium murale* L.
Kuwaiti data: it is a common annual herb. The flowering time: February-April.
* 2n = 18   n = 9

Literature data and comments:
The Kuwaiti somatic count 18 is consistent with many other counts (7 ref. in BOLKHOVSKIKH & al. 1969; 1 ref. in MOORE 1974; 3 ref. in MOORE 1977; 4 ref. in GOLDBLATT 1981; 4 ref. in GOLDBLATT 1984; 1 ref. in GOLDBLATT 1985; 2 ref. in...
GOLDBLATT & JOHNSON 1990; 1 ref. in GOLDBLATT & JOHNSON 1991). There were two references giving the gametic count and both showed the same as Kuwaiti value i. e. n = 9 (1 ref. in MOORE 1973; 1 ref. in GOLDBLATT 1984). This species is well established as diploid state with the basic number of 9.

**Fabaceae (Leguminosae)**

*Alhagi graecorum* Boiss.

Syn.: *A. mannifera* JAUB. & SPACH, *A. tournefortii* HELDR.

Kuwaiti data: It is an uncommon perennial shrub that germinates in hard sandy soil in many places. The flowering time: April-May.

* 2n = 16  
  n = ?

Literature data and comments:
This value of somatic count of Kuwaiti species is the first to be reported. The value of 2n = 28 was previously reported (BOLKHOVSKIKH & al. 1969) Kuwaiti species shows the diploid state and the chromosomes are small.

*Medicago rotata* Boiss.

Kuwaiti data: It was introduced as weed and became constant element in one locality (Failka - Kuwaiti island) but no information was found regarding the description of this species in Kuwaiti records.

* 2n = 16  
  n = 8

Literature data and comments:
The somatic count of this species was found to be 16 (KLIPHUIS & BARKOUDAH 1977, sec. GOLDBLATT 1981; AGARWAL & GUPTA 1983, sec. GOLDBLATT 1985; DIAZ LIFANTE & al. 1992, sec. GOLDBLATT & JOHNSON 1996) which are consistent with the Kuwaiti value. For the gametic count there was only one reported count (AGARWAL & GUPTA 1983, sec. GOLDBLATT 1985) which is 8 and the Kuwaiti value is the second to be reported. The genus *Medicago* showed that the basic number x = 7, 8 (MÁJOVSKÝ & MURÍN 1987).

*Hippocrepis areolata* Desv.

Syn.: *H. bicontorta* LOISEL., *H. cornigera* BOISS.

Kuwaiti data: It is a common annual herb that grows in sandy soil. The flowering time is March.-April.

* 2n = 14  
  n = 7

Literature data and comments:
For this species there is only one reference (DOMINGUEZ 1976, sec. GOLDBLATT 1981) with 2n = 14 and n = 7. The Kuwaiti values are the second to be recorded. The chromosomes are very small. The literature data showed that the basic number, x, of the genus *Hippocrepis* is 7 and the diploid state is the dominant.

*Trigonella anguina* DELILE
Trigonella hamosa L.
Trigonella stellata FORSSK.
Kuwaiti data: They are generally common annual herbs that grow in sandy silt soil in many places. The flowering time is March-April. The somatic and gametic chromosome numbers are the same for the above three species.

* 2n = 16  

n = 8

Literature data and comments:
For *T. anguina*, there is only one reported somatic value showing that 2n = 16 (Bolkhovskikh & al. 1969). For *T. hamosa* there is also reported somatic value of 2n = 16 (Bolkhovskikh & al. 1969, Agarwal & Gupta 1983). For the gametic count, the value was n = 8 (1 ref. Moore 1973; 2 ref. 1977). The somatic value of *T. stellata* was shown to be 2n = 16 (Bolkhovskikh & al. 1969; Moore 1973). The somatic and gametic values of the Kuwaiti species are consistent with other values and showed the diploid state.

**Geraniaceae**

*Erodium laciniatum* (CAV.) WILDL.

Syn.: *Geranium laciniatum* CAV.

Kuwaiti data: It is a common annual or biennial herb, which is found in sandy soil in many places. Flowering time: March-April.

* 2n = 20  

n = ?

Literature data and comments:

**Iridaceae**

*Gynandriris sisyrinchium* (L.) PARL.

Syn.: *Iris sisyrinchium* L.

Kuwaiti data: A perennial herb that grows uncommonly in dry sandy soil. Flowering time: February-March.

* 2n = 24  

n = ?

Literature data and comments:
The somatic number of this species was shown to be 2n = 12 (Goldblatt 1980a, sec. Goldblatt 1984), 24 (Queiros 1980, Garbari & Crisman 1988, Perez & Pastor 1994, Sнogerуп 1995, and Voss & al. 1994, sec. Goldblatt 1985; Goldblatt & Johnson 1991, 1998, respectively), and 48 (Montmollin & al. 1986, sec. Goldblatt & Johnson 1991). The somatic chromosome number of Kuwaiti species, 24, seems to be the tetraploid value as the basic number x = 6. The gametic number has not been detected yet.
Lamiaceae (Labiatae)

Salvia spinosa L.
Kuwaiti data: it is a perennial herb that grows in calcareous soil. The flowering time is March-April.
* 2n = ?  n = 10
Literature data and comments:
The gametic chromosome number for this species n = 10 is the first to be reported. The somatic count was found to be 2n = 20 (Bolkhovskikh & al 1969, Patudin & al. 1975, Kliphuis & Barkoudah 1977, sec. Goldblatt 1981).

Polygonaceae

Emex spinosa (L.) Campd.
Syn.: Rumex spinosus L.
Kuwaiti data: it is a common annual herb that distributes in many sandy places. Flowering time: March-April.
* 2n = 20  n =?
Literature data and comments:
The somatic value was recorded to be 2n = 20 (6 ref. in Bolkhovskikh & al. 1969; Putievsky & al. 1980a, Queiros 1983a, Dalgaard 1986, Queiros 1991b, sec. Goldblatt 1984, 1985; Goldblatt & Johnson 1990, 1994 respectively). The somatic number of Kuwaiti species is consistent with other studies and showed the diploid level.

Rumex vesicarius L.
Kuwaiti data: It is a common annual herb that grows in sandy soil in many places. Flowering time: March-April.
* 2n = 18  n = 9
Literature data and comments:
The Kuwaiti value is consistent with many studies which showed that 2n = 18 (4 ref. in Bolkhovskikh & al. 1969; also Humphries 1978, Dalgaard 1986, Brullo & al. 1990, and Baltisberger & al. 1990, Diaz Lifante & al. 1992, sec. Goldblatt 1981; Goldblatt & Johnson 1990; 1994, 1996 respectively). However, another value of 2n = 20 was recorded (Bolkhovskikh & al.1969). The gametic number in this study is the first time to be reported.

Solanaceae

Lycium shawii Roem. & Schult.
Syn.: L. arabicum Schweinf. ex Boiss., L. albilorum Damm., L. persicum Miers
Kuwaiti data: It is thorny shrub that is found in sandy stone ridges in one locality. The flowering time: March-April.
* 2n = ?  n = 12
Literature data and comments:
MÁJOVSKÝ & MURÍN (1987) showed that the basic number, x, of Lycium L. is = 6. This suggests the polyploidy nature of this genus. No somatic value has been reported during the period from 1981 - 1998.

Zygophyllaceae

Nitraria retusa (FORSSK.) ASCHERS.
Syn.: Peganum retusum FORSSK., N. senegalensis LAM.; N. tridentata DESF. N. sericea JAUB. & SPACH

Kuwaiti data: It is a halophytic shrub that can be found in salt marshes. The flowering time is March-May.
* 2n =?
  n = 12

Literature data and comments:
The gametic chromosome number for this species is reported for the first time in this investigation. The somatic count was recorded to be 2n =24 (HILU 1979, sec. GOLDBLATT 1984; BOLKHOVSKIKH & al. 1969) which confirm the diploid level of this species.

Acknowledgements

We would like to thank Mr. MUHAMMAD MASOOD for his professional technical assistance. This research was supported financially by Kuwait University grant no. SO 072.

References

Because the full list of references would enlarge this paper, we had to shorten this part and refer to the original sources such as BOLKHOVSKIKH & al. 1969 and MOORE 1973, 1974, 1977 (indexes of plant chromosome number IPCN - Regnum Vegetabile 90, 91 and 96) for the relevant data for a particular species. References from elsewhere were mentioned.


Received: 7 June 2000
Revised: 8 November 2000
Accepted: 27 November 2000