Meiotic studies of the Convolvulaceae Juss. from Indian Hot Desert

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ABSTRACT: During the present study meiotic investigations are carried out on some members of family Convolvulaceae collected from different regions of Rajasthan. Total 19 species under 6 genera are meiotically studied. Of these, 2 species, namely, Convolvulus deserti (2n = 18) and Merremia umbellata (2n = 14) are cytologically worked out for the first time from the world and five species, namely, C. glomeratus (2n = 28), C. sabatius (2n = 22), Ipomoea cordatotriloba (2n = 30), I. triloba (2n = 30) and I. sagittifolia (2n = 30) are cytologically worked out for the first time from India.

KEYWORDS: Convolvulaceae, Chromosome counts, Meiosis, Rajasthan

Rajasthan is located in western part of India. This state is situated in North-West part of India, between 23° 03’ and 30° 12’ North latitude and 69° 30’ and 78° 17’ East longitude. The geographical area of the state is 3, 43, 274 sq. km i.e., 11 per cent of total area of India. It has considerable diversity in its soils, topography and in its physiographic features. This state is climatically and edaphically very different from rest of the country. Geographically it is divided into four distinct parts (The Great Indian Thar, The Central Aravalli Mountain Range, The Eastern Plains enriched by rich alluvial soil and The South-Eastern Hadoti Plateau with intrusions of black volcanic rocks). The temperature ranges from 2 °C to 50 °C. The rainfall varies throughout the state; it is as low as 150 mm in the arid region to 1,000 mm in the Southeastern plateau. The human establishments, in the form of hamlets and villages, are few and far between depending upon the availability of water in such area. A large part of the population leads nomadic or semi-nomadic life, their chief wealth being livestock.

The family Convolvulaceae, commonly known as “Morning glory” is cosmopolitan family which consists of 85 genera and 2,800 species (Shahid and Rao 2016) distributed to tropical, sub-tropical and temperate regions of the world. There are about 20 genera and 150 species reported from India (Sultana and Rahman 2016). It is one of the largest and diverse families of angiosperms. Members of the family are mostly twining vines and lianas with few herbs, shrubs and trees are also reported (Shahid and 2016). Most of the members of the family are with twining or erect stems and funnel shaped flowers often with milky latex. Leaves are alternate; simple; entire; dissected. Flowers are often solitary, axillary or in cymes, racemes, panicles with radially symmetrical corolla. Pollen surface ornamentation and aperture type are important characters in the classification of Convolvulaceae. The family is characterized by funnel shaped corolla and epipetalous stamens. The family has large number of endemic genera and is adapted to a wide range of habitats (Barroso et al. 1986; Stefanovic‘ et al. 2002). Cytologically the family is well explored from India as well as outside India, but there is hardly any chromosome report in the family from Rajasthan.

MATERIALS AND METHODS

Extensive field surveys have been carried out to different localities of Rajasthan. The plant specimens were identified with the help of various floras and authenticated from BSI, Jodhpur. For meiotic studies, young flower buds of appropriate size were collected in freshly prepared Carnoy’s fixative (6 parts ethanol: 3 parts chloroform: 1 part glacial acetic acid) for 40 - 48 h, from the plants during the peak flowering time. Plant material was transferred to 70% ethyl alcohol and stored in refrigerator at 4°C until use. Meiotic studies were carried out by crushing anthers to prepare a smear of pollen mother cells (PMCs) in 1% aceto-carmine. The chromosome counts and meiotic abnormalities were confirmed by observing appropriate number of PMCs. Pollen fertility was observed by heating the pollen grains in 50% glycerol - aceto carmine (1:1) solution. The photomicrographs of the PMCs and pollen grains were taken from the temporary slides by using Nikon 80i digital imaging system. Voucher specimens are deposited in Herbarium, Department of Botany, Punjabi University, Patiala (PUP).

New and varied chromosome counts are based on the information collected from standard cytological indices, (Darlington and Wyile 1955; Löve and Löve 1975; Fedorov 1969; Moore 1970, 1971, 1972, 1973, 1974, 1977; Goldblatt 1981, 1984, 1985, 1988; Kumar and Subramanian 1986; Goldblatt and Johnson 1990, 1991, 1994, 1996, 1998, 2000, 2003, 2006; Khatoon and Ali 1993), IAPT/IOPB, CCD Chromosome Reports and journals concerned with chromosome reports as well as Internet sites (Tropicos.org., Missouri Botanical Garden). The results on species of cytological interest are discussed in the following sections.
RESULTS
Detailed meiotic studies have been carried out on 19 species of family Convolvulaceae from different localities of Rajasthan with altitude range of 164m - 920m. The data regarding locality with altitude/latitude, accession number, present chromosome numbers with figure numbers, ploidy level and pollen fertility of the presently worked out species has been presented in Table 1. Cytological data are essential for the study of plant evolution and classification (Stebbins 1971). The different species show lot of diversity in chromosome numbers (2n = 14, 18, 22, 24, 26, 28, 30). All the 19 species studied presently show normal meiosis with high pollen fertility. Brief comments on the chromosome numbers for different species and genera covered presently are discussed further.

Convolvulus is one of the diverse genus of the sub-family Convolvuloideae and family Convolvulaceae, which are widely distributed with more concentration in temperate regions of the world (Carine and Robba 2010; Wood et al. 2015). The centre of biodiversity of the genus is Mediterranean, Western Asia and Macronasia (Carine and Sumbul 2010). The species of the genus are restricted to moist sandy and rocky areas and also in cultivated fields. Many species are common some of them are economically important and are used as food, ornamental, fodder, laxative and as a brain tonic (Agarwal et al. 2014). In India, only 10 species are reported, which are distributed in drier parts (Santapau and Henry 1973). The genus is considered to be polybasic with n = 9, 10, 11, 12 and 15. C. deserti was collected from Udaipur district of Rajasthan. The meiosis of the plant shows 9 bivalents at M-I (Fig. 1). Further, the meiotic course is normal with high pollen fertility. This species is cytologically worked out for the first time from India. The similar chromosome count was reported from Pakistan (Baquar and Husain 1967; Saeed et al. 1990). C. microphyllus Sieber was collected from Jhalawar district of Rajasthan. The meiotic studies reveal the presence of 9 bivalents at M-I (Fig. 4) with normal meiotic course and high pollen fertility.

The chromosome count is already reported. C. sabatius was collected from Gulab Bagh region of district Udaipur. The meiotic studies of the species show the presence of 11 bivalents at M-I (Fig. 5). The species is the first cytological report from India. Earlier 2n = 22 was reported from Italy (Tornadore et al. 1974) and from Middle East (SA'AD 1967).

The genus Cressa is a small genus of 5 species (Faustin 2000) found in tropical and sub-tropical regions of the world. The species are found near dry or saline habitat. C. cretica is commonly known as Rudravanti and was collected from Pali fields. The meiotic studies reveal the presence of 14 bivalents at M-I (Fig. 6) with equal distribution of 14:14 chromosomes at A-I. Further, normal meiosis is reported with high pollen fertility. Present chromosome count is in line with the earlier report from India (Vij et al. 1974). The species has various medicinal properties and is used in traditional medicinal system (Priyashree et al. 2010).

The genus Evolvulus has 70 species distributed all over the world and it is represented in India by 2 species (Nakajima 1931). From India only two species are reported, both the species are used all over India for its therapeutic properties. At present E. alsinoides L. is collected from Mount Abu. The meiotic studies depict the presence of 13 bivalents at M-I (Fig. 7) and equal distribution of 13:13 chromosome at A-I. The pollen fertility is also high with normal meiotic course. Present chromosome count is in line with many earlier reports from India.

The genus Ipomoea is one of the largest genus of the family with about 500 species (Shahid and Rao 2016) distributed throughout tropical and sub-tropical regions of the world with 60 species distributed in India. It includes many medicinal (Rane et al. 2012; Pankaj et al. 2014) and
Table 1. Data showing taxon, its exact collection site, chromosome count, ploidy level, pollen fertility with pollen size and previous reports.

| Taxon/Accession number PUP | Locality/Longitude and Latitude with altitude (m) | Chromosome number (2n) | Ploidy level/Meiotic course | Pollen Fertility (%) | Pollen size (µm) | Previous reports (2n) | Remarks |
|----------------------------|--------------------------------------------------|------------------------|-----------------------------|----------------------|------------------|-----------------------|---------|
|                             |                                                  |                        |                             |                      |                  | Outside India         | India   |
| **Convolvulus L.** (x = 9, 10, 11, 12, 15) |                                                  |                        |                             |                      |                  |                       |         |
| C. desertii Hochst. & Steud. (60868) | Gagron Fort 24°35'45.44” N 76°09'40.17” E, Jhalawar | 18                      | 2x/N                        | 99                   | 39.17×38.7      | -                     | -       |
| C. prostratus Forssk = Convululus pluricaulis (59886) | Mehrangarh Fort 26°17'51.77” N 73°01'15.17” E Jodhpur, 510 m | 18                      | 2x/N                        | 98.56                | 35.48×34.89     | 36, 40, 80            | 18; Tondon and Malik (1959, 1959a), Malik and Grover (1968), Vij et al. (1974), Bir et al. (1978, 1978a) 20; Singh (1951) 36; Tondon and Malik (1959, 1959a) |
| C. glomeratus Choisy (59915) | Monsoon Palace 24°35'33.23” N 73°38'19.44” E, Udaipur, 920 m | 28                      | 2x/N                        | 99                   | 34.77×34.72     | 28                    | -       |
| C. microphyllus Sieber ex Spreng (59885) | Circuit House 24°35'49.45” N 76°09'15.59” E Jhalawar, 332 m | 18                      | 2x/N                        | 100                  | 38.44×37.25     | 24, 36                | 18; Bir and Neelam (1980), Bir and Sidhu (1980) 24; Bir and Neelam (1984) |
| C. sabatius Viv. = C. mauritanias (59902) | GulabBagh 24°34'22.52” N 73°41'31.70” E Udaipur, 591 m | 22                      | 2x/N                        | 97                   | 29.46×3043      | 22                    | -       |
| **Cressa L.** (x = 14) |                                                  |                        |                             |                      |                  |                       |         |
| C. cretica L. (59890) | Gajjar 25°46'02.53” N 73°19'25.68” E Pali, 240 m | 28                      | 2x/N                        | 99                   | 18.49×2049      | 28                    | 28; Vij et al. 1974 (IOPB) |

Previous reports confirmed
### Evolvulus L. \((x = 13)\)

| Species            | Location          | Latitude/Longitude | Chromosomes | Meiosis | Fert. | Previous reports |
|--------------------|-------------------|--------------------|-------------|---------|-------|------------------|
| *E. alsinoides* L. | Mandore Garden    | 26°14'01.54" N 73°01'26.25" E | 26          | 2x/N   | 98    | 34.94x33.43      |
|                    |                   |                    |             |         |       | 22; Bir et al. (1978) |
|                    |                   |                    |             |         |       | 24; Bir et al. (1978) |
|                    |                   |                    |             |         |       | 26; Raghavan (1959), Mehra and Vasudevan (1972), Vij et al. (1973, 1974, 1977), Vasudevan (1975), Bir et al. (1978) |
| *Ipomoea* L. \((x = 15)\)

### Ipomoea L. \((x = 15)\)

| Species            | Location          | Latitude/Longitude | Chromosomes | Meiosis | Fert. | Previous reports |
|--------------------|-------------------|--------------------|-------------|---------|-------|------------------|
| *I. cordatotriloba* | GulabBagh         | 24°34'22.52" N 73°41'31.70" E | 30          | 2x/N   | 100   | 48.36x50.44      |
|                    |                   |                    |             |         |       | -                |
| *I. cairica* (L.) Sweet | 25°46'10.51" N 73°19'26.94" E, Pali, 270 | 30          | 2x/N   | 99    | 59.78x58.56      |
|                    |                   |                    |             |         |       | 28; Sampathkumar (1969) |
|                    |                   |                    |             |         |       | 30; Sharma and Datta (1958) |
|                    |                   |                    |             |         |       | Sampathkumar (1969), Vij et al. (1974, 1977), Bir et al. (1978, 1978a), Sanjappa and Dasgupta (1981), Sampathkumar and Ayyangar (1984), Sinha and Sharma (1992) |
|                    |                   |                    |             |         |       | 30; Rao (1947), Sharma and Datta (1958), Rao and Mwasumbi (1981), Sinha and Sharma (1992) |
| *I. carnea* Jacq   | GulabBagh         | 24°34'22.52" N 73°41'31.70" E, Udaipur, 591 m | 30          | 2x/N   | 100   | 58.33x54.09      |
|                    |                   |                    |             |         |       | 30; Rao (1947), Sharma and Datta (1958), Rao and Mwasumbi (1981), Sinha and Sharma (1992) |
| *I. dichroa* Choisy | Monsoon Palace    | 24°35'33.23" N 73°38'19.44" E, Udaipur, 920 m | 30          | 2x/N   | 98    | 38.56x37.15      |
|                    |                   |                    |             |         |       | 30; Vij and Singh (1974), Vij (1974, 1977) |
| *I. eriocarpa* R. Br = *I. sindica* | Monsoon Palace | 24°35'33.23" N 73°38'19.44" E, Udaipur, 920 m | 30          | 2x/N   | 89    | 25.46x23.11      |
| Species                  | Collection Site               | Latitude/Longitude          | Chromosome Number | Reports (Reference)                                         | Notes                                      |
|-------------------------|-------------------------------|-----------------------------|--------------------|-------------------------------------------------------------|--------------------------------------------|
| *I. obscura* (L.) K. Gawl. (60847) | Monsoon Palace                | 24°35'33.23" N 73°38'19.44" E, Udaipur, 920 m | 30                 | 2x/N 95 41.26×40.23 30(0-3B) 30; Sharma and Datta (1958), Sampathkumar (1968) (Karyological studies) | Previous reports confirmed |
| *I. pes-tigridis* L. (57088)    | 29°34'44.59" N 74°19'43.56" E Hanumangarh, 180 m | 28                 | 2x/N 100 96.07×83.35 28, 30 28; Sampathkumar (1968, 1978, 1979), Bir and Sidhu (1979) 30; Vij et al. (1974), Sampathkumar (1979), Bir and Sidhu(1975, 1979, 1980, 1983) 60; Kaur et al. 2015 | Previous reports confirmed |
| *I. triloba* L. (59918) | 25°46'10.51" N 73°19'20.62" E Pali, 230 m | 30                 | 2x/N 100 46.25×44.78 30, 38 - | First cytological report from India |
| *I. sagittifolia* Ker Gawl. (60848) | 25°46'12.22" N 73°19'25.04" E Pali, 230 m | 30                 | 2x/AB 77 49.27×43.11 - - | First cytological report from India |
| *Jacquemontia* Choisy (x = 9) | Masuria Hill Garden          | 26°16'16.27" N 72°59'44.51" E Jodhpur, 350 m | 18                 | 2x/N 100 29.48×26.48 18, 20 18; Sampathkumar (1974) | Previous reports confirmed |
| *Merremia* Dennst. ex. Endl. (x = 15) | Ranakpur                     | 25°06'57.35" N 73°28'21.02" E, Pali, 484 m | 14                 | 2x/N 95 23.45×21.22 - - | First cytological report from World |

***Previous chromosome number reports are compiled from ‘Chromosome Atlas of Flowering Plants’ (Darlington and Wylie 1955), Chromosome Numbers of Flowering Plants’ (Fedorov 1969), Index to Plant Chromosome Numbers’, 1974 onwards. ‘IOPB Chromosome Number Reports’ as published in Taxon from 2006 onwards, and some important references included in Journals and Biological Abstracts and only those included in text are mentioned under chapter 7 (References) for the sake of conciseness.***
ornamental plants. Lysergol, an alkaloid, has been isolated from some species of the genus (Pullaiah 2006). The first cytological study on the genus was made in *I. nil* with 2n = 30 (Yasui 1928). The majority of the species shows n = 15. Anueploid cytotypes of n = 14 was reported for the first time in *I. coccines* (Nakajima 1931). Presently, *I. cordatotriloba* is collected from Udaipur district of Rajasthan. Meiosis of the plant shows 15 bivalents at diakinesis (Fig. 8). The species is cytologically worked out for the first time from India. *I. cairica* was collected from Pali district of Rajasthan. Meiotic study shows 15 bivalents at M-I (Fig. 9). The present chromosome count is in line with many earlier reports. Chromosome counts of 2n = 30, 60 are reported from outside India. *I. carnea* was collected from Udaipur. The species has wide range of distribution growing in arid, aquatic and hills. Meiosis of the plants depicts 15 bivalents at diakinesis (Fig. 10). Further, the meiotic course is normal with high pollen
fertility. Present chromosome count is in line with many earlier reports (Table 1). *I. dichroa* was also collected from Udaipur district. Meiotic studies shows 15 bivalents at M-I (Fig. 11) with normal meiotic course and high pollen fertility. Present chromosome report is conformity with many earlier reports from India (Table 1). *I. eriocarpa* is collected from Udaipur district of Rajasthan. Meiosis of the species shows 15 bivalents at diakinesis (Fig. 12). The pollen fertility is also normal as meiotic course is normal. The present chromosome count is in line with the earlier reports from India. It is also reported from Pakistan (Khatoon and Ali 1993). *I. nil* was collected from Sri Ganganagar district. Meiotic studies show the presence of equal distribution of 15 bivalents at M-I (Fig. 13). Further, the meiotic course is normal with high pollen fertility.

The present chromosome count is in line with earlier reports from different geographical regions India. Similar chromosome count was also reported from Australia (Yen et al. 1992) and China (Chen et al. 2003). *I. obscura* was collected from Udaipur. The meiotic studies show 15 bivalents at M-I (Fig. 14). The pollen fertility is also recorded to be high owing to normal meiotic count. The present chromosome count is in line with earlier report from India. Besides this, presence of 30 (0-3) B-chromosomes from Taiwan was also reported (Yeh and Tsai 1995). *I. pes-tigris* was collected from Hanumangarh district. Meiosis of the plant shows 14 bivalents at M-I (Fig. 15). Earlier, the chromosome count of 2n = 28 (Yeh and Tsai 1995) and 2n = 60 (Kaur et al. 2015) was also reported for the species. *I. triloba* was collected from Pali. The meiosis of the plant shows 15 bivalents at diakinesis (Fig. 16). The meiotic course is normal with high pollen fertility. The species is worked out for the first time from India. Earlier, similar chromosome count was reported from Australia (Yen et al. 1992) and from Taiwan (Yeh and Tsai 1995). The chromosome count of 2n = 38 was also reported for the species (Wang et al. 1998) from China. *I. sagittifolia* was collected from Pali district. The meiotic course of the plant shows 15 bivalents at diakinesis (Fig. 17). The species is cytologically worked out for the first time from world.

The genus *Jacquemontia* comprises of 120 species mainly distributed to America with few occurring in Asia and Africa (Pastore and Simão 2016). Presently, *J. pentantha* was collected from Jodhpur. The meiotic studies show 9 bivalents at diakinesis (Fig. 18). Further, the course of meiosis is normal with high pollen fertility. The present chromosome count is in line with the earlier chromosome reports from South India (Sampathkumar 1979). The chromosome counts of 2n = 18 and 20 are also reported from outside India.

The genus *Merremia* consists of about 100 species distributed to tropical and sub-tropical regions of the world. The members of the genus grow in variety of habitats ranging from grasslands to dry forest, even in cultivated areas. *M. umbellata* was collected from Ranakpur region of Rajasthan. The meiotic studies of the species show 7 chromosomes at A-II (Fig. 19). The species is cytologically worked out for the first time from India.

**DISCUSSION**

Present work is the first attempt to work out the cytomorphology of the plants of family Convolvulaceae from different altitudes of Rajasthan commonly Indian Thar desert. These new/varied chromosome counts have enriched the chromosome numbers database of India. The present studies report all the species to be diploid with normal meiotic course. Earlier, cytological studies in 31 species and 8 genera of the family has been carried out from India (Vij et al. 1977). All the species were reported to be at diploid level of ploidy, which may be due to a multiple suppressor system or due to acute property of preferential pairing. The present results also show diploid level of ploidy and normal meiotic course in all the species, i.e., *Convolvulus desertii* (2n=18) and *Merremia umbellata* (2n=14) are cytologically worked out for the first time from the World, whereas, five species, namely, *Convolvulus glomeratus* (2n=28), *C. sabatus* (2n=22), *Ipomoea cordatotriloba* (2n=30), *I. triloba* (2n=30) and *I. sagittifolia* (2n=30) are cytologically worked out for the first time from India. Recent attempts have made to explore the cytomorphological diversity in the plants of geographically isolated areas of Western Himalayas (Lahaul-Spiti, Kinnaur and Pangi Valley, Kangra, Sirmaur, Chamba and Kullu) and unexplored area of Jammu and Kashmir had resulted into interesting findings in several species in the form of intraspecific cytotypes, apomicts and triploids (Kumar 2010; Kaur 2012; Malik 2012; Farroq 2013).

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