6. SUMMARY

Biosystematical studies of some taxa of Euphorbiaceae have been made in order to understand the interrelationship among the species. Of the 24 taxa studied, the first record of chromosome number has been made in *Phyllanthus myrtifolius*, *Sauropus androgynus*, *Aporosa lindleyana*, *Baccaurea courtallensis*, *Croton variegatum*, *Croton sparsiflorus*, *Acalypha fruticosa* and *Jatropha glandulifera*. Deviant record of chromosome number as against the previous reports has been made in *Chrozophora rottleri* and *Excoecaria agallocha*. In the rest of the species studied, the present report of chromosome numbers confirm the earlier record of chromosome numbers.

A common survey of the chromosome numbers in Euphorbiaceae reveal the existence of graded series of haploid numbers from 6 to 114. Of those haploid numbers n=10, n=11 and n=13 represented the highest frequency among the taxa studied. Therefore, it may be assumed that the original primary basic number may be 10 and it should have given rise to derived basic number 11 and 13. A process of chromosomal reduction as observed among the species of *Crepis* might have got reduced to n=9, n=8 and finally to n=6 by a series of unequal translocations involving concurrent loss of inert heterochromatin parts of the chromosomes. The
other higher haploid numbers above the level of \( n=11 \) should have arisen by means of aneuploidy and euploidy.

In the present study, critical karyotype analysis of as many as 24 species of Euphorbiaceae showed asymmetrical karyotypes. Besides this, the other advanced characters are evidenced by the presence of Shortest chromosome/Longest chromosome ratios, Short arm/Long arm ratios, their relative length and also the common occurrences of sub-terminal kinetochores, showed that this family may be considered as one of the most evolved families of Angiosperms.

As revealed by karyotype analysis of 24 species of Euphorbiaceae studied it is clear that, there is a close correlation between the size and the number of somatic chromosomes.

Meiotic studies have been made in 18 taxa of Euphorbiaceae in the present investigation. The meiotic chromosome number is in confirmation with the somatic chromosome number of the various species studied.

Meiotic irregularities such as precocious movement of chromosomes, lagging chromosomes micro and macro nuclei formations, irregular anaphase and sticky chromosomes during metaphase and anaphase have been rarely observed. Meiotic observation such as
chromosomal bridges, laggards and precocious movement of chromosomes have also been observed occasionally.

All the taxa of Euphorbiaceae studied are linked together by the uniform presence of paracytic stomata. But in few species in addition to paracytic type of stomatal distribution the occurrence of anamocytic and anisocytic type of stomatal distribution are also recorded. Similarly, in all the other epidermal characteristics such as amphistomatic or hypostomatic conditions, stomatal index and stomatal frequency, each and every species studied is more or less distinct. Even the species of a particular genus have different stomatal index of lower epidermis, as evidenced by the present investigation among the species of Euphorbia, Phyllanthus, Croton, Acalypha and Jatropha. Therefore, the present epidermal study shows that the taxa studied are polyphyletic in nature.

In the presence of granular wall ornamentations of pollen grains, all the taxa studied are linked together. There are occurrences of tricolpate, tetracolpate and polycolpate pollen grains among the species studied. Even a particular species possesses both tricolpate and polycolpate pollen grains. At species level, the various taxa palynologically studied are related together. But, at generic level, they are not so much related together. Therefore, it is concluded that the taxa studied are polyphyletic in nature.
Leaf anatomy have been investigated in 24 taxa of Euphorbiaceae in order to find out the anatomical variations for species identification. There is a range of characters which varies between species. Leaf is a variable organ. The leaf of a same plant has different shape and size. Basically leaf of monocotyledons are called isobilateral and dicotyledons are named as dorsiventrally differentiated. In general the dorsiventrally differentiated leaves of dicotyledons have upper and lower epidermis, mesophyll tissues and vascular bundles. The upper epidermis may be with or without stomata and the lower epidermis may have stomata. The upper epidermis have one, two or multilayered parenchyma cells and this character is species specific. Similarly the presence of palisade parenchyma just below the upper epidermis is always a common phenomenon and also species specific. The presence of single, double and multiple layer of palisade parenchyma is a tool in taxonomic classification. Just above the lower epidermis, the spongy parenchyma are many layers (5 to 10 rows) with storage tissues, transfusion tissue, water and air spaces. The vascular bundles (xylem and phloem) are distributed in the vein, mid-vein and in the ground tissue (Mesophyll tissue) of the lamina. Since, Euphorbiaceae is commonly called as a latex and rubber yielding family, the plant system has latex cells, latex vessels and secretary cells in leaves and stems. Latex, alkaloids and tannin containing cells are observed in this family, as they are specialized
structures seen among the various genus and species. Also crystals and raphides are recorded in the mesophyll tissues of leaf.

The following feature are observed in the various species of Euphorbiaceae studied.

1. Thick cuticle are observed in all the species studied.
2. In upper epidermis single row of epidermal cells (Parenchyma) occur in all the species studied except Pedilanthus tithymaloides, Acalypha fruticosa, Ricinus communis, Jatropha glandulifera and Manihot utilissima; where they are two or three rows.
3. The mesophyll tissues are differentiated into palisade and spongy parenchyma in all the species studied except, Euphorbia tirucalli and Aporosa lindleyana. In the two species (Euphorbia tirucalli and Aporosa lindleyana); the mesophyll tissue are only spongy parenchyma.
4. The occurrence of single row of palisade parenchyma have been observed in all the species of Euphorbiaceae studied, except Euphorbia splendens; Pedilanthus tithymaloides; Croton variegatum; Acalypha fruticosa; Jatropha glandulifera; Jatropha curcas; Jatropha gossypifolia; Jatropha multifida and Excoecaria agallocha. In all the above mentioned species, there are two or
rarely three rows of palisade parenchyma cells present, to enhance the photosynthetic rate and efficiency for quick growth and regeneration.

5. In *Chrozophora rottleri*, the occurrence of palisade parenchyma on both sides of the lamina surfaces (upper and lower side) and spongy parenchyma and vascular bundles are occurring in between them. Hence, *Chrozophora rottleri* is considered as unique with regards to mesophyll tissue distribution.

6. The vascular bundles in mid-vein, lateral vein in the mesophyll tissues and in the lamina surfaces are uniform throughout the various species of Euphorbiaceae, studied.

7. The latex, laticiferous tissues, latex vessel and resinous ducts are familiar in this family Euphorbiaceae (*Hevea, Jatropha* and *Excoecaria*).

8. All the species studied here, showed Rubiaceous type of stomatal distribution (Paracytic type), with rare occurrence of anisocytic and anomocytic type in few species of the angiospermic family Euphorbiaceae.

**Cyto-taxonomical considerations**

The family Euphorbiaceae starts with the genus *Euphorbia*, that are herbs, shrubs and some trees of various habit and with copious
milky, usually acrid juice. Inflorescence of many pedicelled bracteolate stamens as male flowers surrounding a single pedicelled female, the whole contained in a 4-5 lobed involucres. In *Euphorbia*, involucres regular or nearly so whereas, involucres obliquely zygomorphous in *Pedilanthus*. Of the three species studied in *Euphorbia*, *Euphorbia hirta*, is a straggling ascending hispid herb reaching up to 2 feet high. *Euphorbia tirucalli* is a large shrub, with very small flower, the bracteoles among the male lacinate at tip; wood hard, said to give a good powder charcoal. *Euphorbia splendens* is a small prickly very much branched shrub with showy crimson flower common in gardens in the plains. These species are characterized by monoecious flowers combined in inflorescences of many male florets surrounding a solitary female. Cytologically these species possesses 2n=20 (*Euphorbia hirta; Euphorbia tirucalli*) and 2n=40 (*Euphorbia splendens*); chromosomes. All the three species have latex in their vegetative organs. Cytologically, except *Euphorbia splendens* the other two species have secondary constricted chromosomes. Cytologically, *Euphorbia splendens* is unique in the sense it has sub-terminal chromosomes with tetraploids 2n=4x=40.

In *Pedilanthus tithymaloides* four secondary constricted chromosomes and six sub-terminal chromosomes are present. The somatic chromosome number is 2n=36. This species is different from
*Euphorbia*, in the presence of cyathium distinctly bilaterally symmetrical, glands hidden within a well developed nectar spur. But in *Euphorbia* cyathium radially symmetrical, glands inserted on outside of cyathium.

The three species of *Phyllanthus* studied namely *Phyllanthus niruri*, *Phyllanthus acidus* and *Phyllanthus myrtifolius* are herb and shrubs, with slight morphological variations among them. *Phyllanthus niruri* is a herb with membranous leaves broadly obtuse at apex, very variable in size but usually under 0.5 inch long. It is often used in native medicine. *Phyllanthus acidus* is a shrub, presumably cultivated for its edible fruits. In these two species, the somatic chromosome numbers is the same, that is, 2n=26. *Phyllanthus myrtifolius* is a large shrub with 2n=52 chromosomes; a tetraploid species (2n=4x=52). Plants monoecious. Inflorescence are axillary several flowered fascicle; pedicels filamentous, unequal, 3-5 mm. Male and female flowers are distinctly present in the same plant. Capsule fruit with 3-angled seed is characteristic of *Phyllanthus myrtifolius*. It is cultivated for medicine.

*Emblica officinalis* is a large tree, monoecious, deciduous, with reduced short group of leafy shoots. Male and female flowers are distinct with globose drupe fruit, 1-1.5 cm in diameter, rich in vitamin C. The somatic chromosome number is 2n=98 in this species and no other species studied has this diploid number of chromosomes. This species is
also characterized by the presence of secondary constricted chromosome with 18 sub-terminal chromosomes. This species is a polyploidy in occurrence with \(2n=7x=98\) \((x=4)\) aneuploidy polyploids.

The species of *Sauropus androgynus* is a shrub with monoecious flowers it is commonly called multivitamin plants, since, the leaves are edible. Cytologically this species has \(2n=24\) chromosomes and, it differs from the species of *Aporosa lindleyana* and *Baccaurea courtallensis*; which possess \(2n=52; 2n=36\) chromosomes respectively. All the three Genera have secondary constricted chromosomes, uniformly six number in each taxon. Further, morphologically *Aporosa lindleyana* is a medium sized evergreen tree with coriaceous leaves. Flower dioecious, male minute, clustered catkin-like spikes and female in short bracteate spikes. Fruit a globose capsule with oblong seeds. *Baccaurea courtallensis* is also an ever green tree remarkable for the flowers growing in long racemose spikes in tuffs on tubercles on the stems and branches, often, “in great profusion, the whole trunk appearing as a crimson mass”. Fruits crimson, about one inch in diameter; edible. In studying all the three species, morphologically and cytologically they are distinct and different among themselves with reference to habit, habitat and diploid chromosome numbers.
Croton variegatum and Croton sparsiflorus both have the somatic chromosome number is 2n=64, with secondary constricted chromosomes and sub-terminal chromosomes. But morphologically, they differ chiefly. Croton variegatum, is a large shrub and Croton sparsiflorus is a herb; they show their species specificity. Both species are cytologically similar but morphologically different.

Chrozophora rotteri, Acalypha indica, Acalypha fruticosa and Ricinus communis differ among themselves in morphological characters particularly in the nature of habit, habitat, inflorescences and flowers. Chrozophora rotteri has 2n=44 chromosomes; Acalypha indica 2n=20; Acalypha fruticosa 2n=20 and Ricinus communis 2n=20. Except, Chrozophora rotteri all the three species have 2n=20 chromosomes with S, J, V type of chromosomes. In Chrozophora rotteri the diploid chromosome number is 2n=44 with the presence of ‘B’ chromosomes but with the absence of secondary constricted chromosomes. Cytologically Chrozophora rotteri differs from the other three taxa in the absence of secondary constricted chromosomes.

The species of Jatropha studied namely Jatropha glandulifera, Jatropha gossypifolia, Jatropha curcas and Jatropha multifida are large shrubs or small trees. The somatic chromosome number in all the species of Jatropha studied are 2n=22 with secondary constricted
chromosomes and sub-terminal chromosomes. Morphologically they differ among themselves by the presence of flowers greenish yellow in *Jatropha glandulifera*; reddish flower in *Jatropha gossypifolia*; yellowish green in *Jatropha curcas* and bright red flowers in *Jatropha multifida*. In comparing all the four species of *Jatropha*, *Jatropha curcas* is very useful in medicine and bio diesel crop where the seeds have yielded oil cultivated in Indian and other tropical countries for seed harvest.

*Hevea brasiliensis*, *Manihot utilissima* and *Excoecaria agallocha* differ among themselves in morphological characters, particularly in the nature of habit, habitat, inflorescence and flowers. *Hevea brasiliensis* has 2n=72 chromosomes and absence of ‘B’ chromosomes is unique and species specific and differ from the other two taxa, have the same diploid somatic chromosome number, but with the presence of ‘B’ chromosomes. Characteristically all the three taxa have secondary constricted chromosomes. Further all the three species have potential economic values, *Hevea* as Rubber yielding, *Manihot* as starch yielding and *Excoecaria* as latex yielding with specific utilization. The habitat of *Hevea brasiliensis* is along the river bank in its native home; Brazil of America, whereas as in other parts of world, it may be well grown in mountainous region. Similarly the habitat of *Manihot utilissima* is mesophytic, and the roots are modified into tuberous form, where the photosynthetic
products are stored as starch. Again the habitat of *Excoecaria agallocha* is in brackish water, tidal forests and swamps on both coasts. It is an evergreen tree with a poisonous milky juice. This plant is considered as a Temple tree (It is planted in Lord Nataraja Temple of Chidambaram, Tamil Nadu, India).

On the basis of the present Cytotaxonomical consideration the following 7 group may be recognized, the first group with *Euphorbia hirta*, *Euphorbia tirucalli*, *Euphorbia splendens* and *Pedilanthus tithymaloides*, the second group with *Phyllanthus niruri*, *Phyllanthus acidus*, *Phyllanthus myrtifolius* and *Emblica officinalis*, the third group with *Sauropus androgynus*, *Aporosa lindleyana* and *Baccaurea courtallensis*, the fourth group with *Croton variegatum* and *Croton sparsiflorus*; the fifth group with *Chrozophora rottleri*, *Acalypha indica*, *Acalypha fruticosa* and *Ricinus communis*; the sixth group with *Jatropha glandulifera*, *Jatropha gossypifolia*, *Jatropha curcas* and *Jatropha multifida* and the seventh group with *Hevea brasiliensis*, *Manihot utilissima* and *Excoecaria agallocha*. Therefore, the cytotaxonomical studies clearly show that these 24 taxa studied reveal the polyphyletic nature of origin and evolution. Only by the presence of mostly 10 and 11 basic chromosome numbers and by the presence of milky juice, latex and oil from seeds inflorescence axillary or terminal, flowers in cymes or fascicles they are arranged along
an elongated axis, branched axis, in congested heads or in a flower like cyathium with reduced flowers enclosed within a ± cupular involucre bracts sometimes petaloid, by which the species of Euphorbiaceae are linked together forming a particular family.

The graph drawn on the basis of frequency distribution of diploid chromosome numbers among the species of Euphorbiaceae studied also shows a poly-model curve. The species of Euphorbiaceae are polyphyletic in nature, showing thereby the evolution of species in multifarious directions as evidenced by the cytotaxonomical investigation and biosystematical investigations with special reference to palynological, epidermal and anatomical studies.

Thus this dissertation is an investigation into the polyphyletic nature of 24 species of Euphorbiaceae on the lines mentioned above and seeks to be an attempt towards advancement of knowledge.
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Biosystematical studies in some taxa of Jatropha Linn.

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Abstract

Biosystematical studies in four taxa of Jatropha have been made to understand the interrelationship among them. The following are the taxa studied with reference to morphological, anatomical and cytological characters (Jatropha curcas, Jatropha gossypifolia, Jatropha glandulifera, and Jatropha multifida). The study revealed that the various species of Jatropha differ morphologically among one another in leaf shape, size and texture. Anatomically the species of Jatropha differ from one another in epidermal cells; number of stomata; stomatal index and mesophyll tissue. Further, the leaf anatomies reveal a typical dicotyledonous type of leaf with a single palisade layer in all the taxa except J. curcas (two rows of palisade cells) and hence it has increase photosynthetic efficiency than the other species. All the species of Jatropha have the Rubiaceous type of stomata (paracytic). Detailed karyotypic analysis has been made in addition to the study of absolute chromosome length, average chromosome length, total chromosome length, relative chromosome length and arm ratio. In all the species, the chromosome number recorded is 2n=22. The chromosomes were classified on the basis of length of the chromosome, position of the centromere, primary and secondary constructions, presence or absence of satellite.

Keywords: Jatropha, morphology, anatomy, cytology, biosystematics

Received: 14th Dec 2012; Revised: 26th January; Accepted: 19th February; © IJCS New Liberty Group 2013

Introduction

Biosystematical studies have been made with reference to morphology, leaf anatomy and cytology in some taxa of Jatropha, belonging to Euphorbiaceae. The family Euphorbiaceae is commonly known as, spurge family. It consists of 334 genera (Webster, 1994) and over 8,000 species (Radcliffe-Smith, 2001), which are distributed mainly in the tropics, in several types of vegetation and habitats. It is one of the most complex, large and diverse families of angiosperms. Wurdack et al. (2004) considered Euphorbiaceae as a pan tropical family, composed of 340 genera and approximately 8,000-9,000 species. The genus Jatropha belongs to the family, Euphorbiaceae with approximately 170 known species distributed in tropical and subtropical Africa and America. Jatropha curcas is a multipurpose shrub with significant economic importance having the capability to rehabilitate the degraded lands (Ghose et al., 2007). It is also considered as a biodiesel plant with economical and medicinal values Dhakshnamoorthy and Selvaraj (2010); Dhakshnamoorthy et al. (2011) and Sundari et al. (2011). Plants of this genus are herbs, shrubs or small trees, monoecious (rarely dioecious), exudate is watery to white; possess poisonous substance in the sap and seed, leaves alternate, often digitately lobed. Flowers are terminal cymes with a single pistillate flower at the end of the primary axis. Sepals are 5 in number, free, imbricate; petals-5, mainly free; staminate disc annular or 5 free
glands, stamens 6-10, in two whorls; pistillate foliaceous annular, 5-lobed; fruits capsular to tardedly dehiscent and sub-drupaceous. Even though 12 *Jatropha* species were notified in several Indian floras, research has been confined to nine species only. Among the *Jatropha* species, *J. curcas* is the most primitive form and has the potential to be cultivated for biodiesel and medicinal properties.

**Materials and Methods**

The plant materials (*Jatropha curcas, Jatropha gossypifolia, Jatropha glandulifera* and *Jatropha multifida*) were collected from the experimental field at Aurangabad in Chidambaram, Tamil Nadu. The cultivated species were identified with the help of Bailey’s (1933), the Standard encyclopedia of horticulture and the Antony Huxley’s, The Macmillan-world Guides of house plants. The wild species were identified with the help of Flora of Madras Presidency (Gamble, 1956). Plants twigs were collected for morpho anatomical studies and stored in 70% ethanol for laboratory studies. Hand free section of leaves were taken and mounted in 50% glycerine for observation. All of them were photographed and tabulated. Dermal studies were also made from the peeling of leaf, by mechanical striping. Root tip squash were made, following the schedule of Iron Alum Haematoxylin squash technique described by Mariamthu and Subramanian (1960) and the important figures were photographed.

**Results and Discussion**

**Morphological and anatomical observation**

The leaf is a variable organ. In *J. curcas* the leaves are 3-5 lobed, cordiform, stipules deciduous. *J. gossypifolia* leaves are opposite 3-5 lobed, deciduous in winter, stipules are ciliate, petiole and leaf blade covered with glandular hairs. *J. glandulifera* Leaves are palmate, 3-5 lobed, margin serrate, serratures and stipules gland-dipped and *J. multifida* Leaves 20-35 cm length across, 5-11 lobes ob lanceolate, again lobed at apex, glaucous beneath, acuminate base obtuse or cordate, petioles up to 20 cm long, green above, often pale pink below and turns to green at maturity. Morphologically all the species the leaves are 3-5 lobed except *J. multifida* as it was 5-11 lobes (Fig. 1). Anatomical work in higher plants has been made by several authors (Cuttee, 1971; Ahmed, 1976; Selvaraj and Subramanian, 1979). The leaf anatomy of Euphorbiaceae is unique in the sense that it is latex yielding. The leaf region was made up of latex cells and laticiferous tissues (Fig. 2) for translocation of latex.

The leaf anatomy showed the following details; the section showing upper and lower epidermis, the distribution of stomata, the arrangement of palisade parenchyma, spongy parenchyma, cystolith in the mesophyll cells (Fig. 2) and vascular bundles in leaf were species specific. The leaf anatomy showed amphistomatic condition in *J. curcas* and *J. glandulifera*, hypostomastic condition in *J. gossypifolia* and *J. multifida* all these species of *Jatropha* have Rubiaceous type of stomata (paracytic) (Fig. 3) with a single layer of palisade parenchyma (except *J. curcas*) and many rows of spongy parenchyma with arendchyma cells. The leaf anatomy of other three species namely *J. gossypifolia, J. glandulifera, J. multifida* were similar to that of *J. curcas* except in layer of palisade cells. Crystals were recorded in the mesophyll tissues of leaf. All the features described, were noted in this present study and re-confirmed (Figs. 1 & 2).

**Cytological observation**

A detailed karyomorphological study of *Jatropha* was made with reference to somatic metaphase
Fig. 1. Morphology of *Jatropha* species (a. *J. curcas*, b. *J. gossypifolia*, c. *J. glandulifera* & d. *J. multifida*).

Fig. 2. *Jatropha curcas* – Leaf section. Anatomy of *J. curcas* leaf (a. Dorsiventrally differentiated (dicot) leaf with cystolith, multilayered palisade parenchyma and transfusion tissue (Transfer cells), b. Enlarged view of transfusion tissue (Transfer cells) and Latex vessels (Laticiferous tissues), c. Cystolith (Calcium oxalate crystals) as a reserved food material characteristics to the family Euphorbiaceae).
Fig. 3. *Jatropha curcas* – Leaf Epidermis. Epidermal peeling of *J. curcas* (a. *J. curcas* stomata (Paracytic type) and b. Enlarged view of stomata with two guard cells and two subsidiary cells parallel to the guard cells (Paracytic type) with surrounding epidermal cells).

**Table 1.** Karyotype analysis of *Jatropha curcas* Linn. (2n=22)

<table>
<thead>
<tr>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>Ratio L/S</th>
<th>Relative length</th>
<th>Position of centromere</th>
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<td>I 4</td>
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<td>0.8</td>
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</table>

The somatic chromosome number has been observed to be 2n=22 (Fig. 4a). This is in conformity with the previous finding (Perry, 1943; Miller and Webster, 1962). The absolute chromosome length is: 26 µm. The average chromosome length is: 2.5 µm. Karyotype formula = 2n=22=S2+3.4 µm+S1=3.0 µm+V6=2.8 µm+V1=2.2 µm+J1=2.4 µm+I1=1.2 µm.

**Table 2.** Karyotype analysis of *Jatropha gossypifolia* (2n=22)

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</table>

The somatic chromosome number has been observed to be 2n=22 (Fig. 4b). This is in conformity with the previous finding (Perry, 1943; Miller and Webster, 1962). The absolute chromosome length is: 28 µm. The average chromosome length is: 2.6 µm. Karyotype formula = 2n=22=S2=3.6 µm+S1=3.0 µm+V6=3.0 µm+V1=2.4 µm+J1=2.4 µm+I1=1.2 µm.
Table 3. Karyotype analysis of *Jatropha glandulifera* (2n=22)

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<td>1.2</td>
<td>1.0 8.8</td>
</tr>
<tr>
<td>J 4</td>
<td>2.2</td>
<td>1.4</td>
<td>0.8</td>
<td>1.7 8.1</td>
</tr>
<tr>
<td>I 4</td>
<td>1.4</td>
<td>1.0</td>
<td>0.4</td>
<td>2.5 5.1</td>
</tr>
</tbody>
</table>

The somatic chromosome number has been observed to be 2n=22 (Fig. 4c). This is the first report of chromosome number. The absolute chromosome length is: 27 µm; The average chromosome length is: 2.5 µm. Karyotype formula = 2n=22-S₂=3.4 µm+S₁²=3.0 µm+V=3.0 µm+V¹ =2.4 µm+J=2.2 µm+I=1.4 µm.

Table 4. Karyotype analysis of *Jatropha multifida* (2n=22)

<table>
<thead>
<tr>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>Ratio L/S</th>
<th>Relative length</th>
<th>Position of centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type No</td>
<td>Total length</td>
<td>Long arm</td>
<td>Short arm</td>
<td></td>
</tr>
<tr>
<td>S 2</td>
<td>3.2</td>
<td>2.0</td>
<td>1.2</td>
<td>1.6 12.3</td>
</tr>
<tr>
<td>S¹ 2</td>
<td>3.0</td>
<td>2.0</td>
<td>1.0</td>
<td>2.0 11.5</td>
</tr>
<tr>
<td>V 6</td>
<td>2.6</td>
<td>1.3</td>
<td>1.3</td>
<td>1.0 10</td>
</tr>
<tr>
<td>V¹ 4</td>
<td>2.4</td>
<td>1.2</td>
<td>1.2</td>
<td>1.0 9.2</td>
</tr>
<tr>
<td>J 4</td>
<td>2.4</td>
<td>1.6</td>
<td>0.8</td>
<td>2.0 9.2</td>
</tr>
<tr>
<td>I 4</td>
<td>1.2</td>
<td>0.8</td>
<td>0.4</td>
<td>2.0 4.6</td>
</tr>
</tbody>
</table>

The somatic chromosome number has been observed to be 2n=22 (Fig. 4d). This is in conformity with the previous finding (Perry, 1943; Miller and Webster, 1962). The absolute chromosome length is: 26 µm; The average chromosome length is: 2.4 µm. Karyotype formula = 2n=22-S₂=3.2 µm+S₁²=3.0 µm+V=2.6 µm+V¹ =2.4 µm+J=2.4 µm+I=1.2 µm. Chromosome: The morphology of chromosomes, diploid number of a species, are important for species differentiation. Cytological work on various genera and species of Euphorbiaceae were carried out (Lewis et al. 1962; Mangenot and Mangenot, 1962; Abraham et al., 1964). The chromosomes were classified on the basis of primary and secondary constrctions and presence or absence of satellite. For the categorization, of chromosomes the following method of Levizky (1931) has been adopted. S = Long chromosome with submedian primary centromere and subterminal secondary centromere. S¹ = Short chromosome with submedian primary centromere and subterminal secondary centromere.

J = Long chromosome with submedian centromere

J¹ = Short chromosome with submedian centromere

V = Long chromosome with median centromere

V¹ = Short chromosome with median centromere

I = Chromosome with subterminal centromere

B = 'B' chromosome

Karyotype formulae have been made for all the species studied and presented in separate table for each taxa.
It was noted that in all the species of *Jatropha* 2n number was 22. The symbol adopted for the morphology of chromosome is according to Levitzky (1931) (Fig. 4).

**Fig. 4.** Diploid chromosome number of *Jatropha* species 2n – 22 chromosomes (a. *J. curcas*, b. *J. gossypifolia*, c. *J. glandulifera*, d. *J. multifida*)

**Conclusion**

Bio-systematical studies with special reference to morphological, anatomical and cytological characters have been made in four taxa of *Jatropha*, to understand the interrelationship among them. In this study, anatomical studies of leaf sections were made in all the species of *Jatropha* revealed unique features. Of these, *J. curcas* has more laticiforous tissues than the other three species. Similarly in *J. curcas* the photosynthetic tissues, particularly the palisade had two or three rows of cells in contrast to the other three species (*J. gossypifolia*, *J. glandulifera*, *J. multifida*). Thus, the anatomical based taxonomical investigation showed *J. curcas* is highly evolved taxa than the other species. Cytological studies with special reference to somatic and meiotic chromosome numbers, size, morphology of somatic chromosomes and mitotic and meiotic abnormalities have been made in the four taxa of *Jatropha*, to understand the interrelationship among them. First record of chromosome number has been made in one taxa (*J. glandulifera*) and chromosome number of the rest of the species confirms the earlier records. The cytological studies (mitosis) show that the basic chromosome number of *Jatropha* is n=11 (haploid-gamic) and 2n=22 (diploid-somatic) chromosome numbers are of common occurrence in all the taxa of *Jatropha* species studied. The presence of asymmetrical karyotypes, shortest chromosome / longest chromosome ratios, short arm / long arm ratios, relative length of chromosomes and sub terminal kinetochores reveal the advanced cytological characters of the genus *Jatropha* and the family Euphorbiaceae. *J. curcas* is a biodiesel yielding plant and the rest of the three species of *Jatropha* are ornamental with medicinal values. Thus, this study is an investigation of the four taxa of *Jatropha* in the family Euphorbiaceae which forms an attempt towards an advancement of knowledge.

**Acknowledgements**

The authors are thankful to the authorities of Annamalai University and Dr. R. Panneerselvam, Professor and Head, Dean Faculty of Sciences, Department of Botany, Annamalai University for having provided laboratory facility and encouragements.

**References**


Karyomorphological studies in some taxa of Euphorbiaceae

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Received: 10 June 2013/Accepted: 25 June 2013/Published online 29 June 2013
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ABSTRACT

The chromosome number of eight species belonging to seven genera of Euphorbiaceae from Southern India has been studied. The chromosome number ranging from 2n=10 to 2n=72. First record of chromosome number have been made from two species and deviant record of chromosome number as against the previous report have been worked out in one species. In the rest of the species studied, the present report of chromosome numbers confirms the previous record. Detailed karyotypic analysis has been made in addition to the study of absolute chromosome length, average chromosome length, total chromosome length, relative chromosome length and arm ratio. The chromosomes were classified on the basis of length of the chromosome, position of the centromere, primary and secondary constrictions, presence or absence of satellite. In the present study, critical karyotype of as many as eight species of Euphorbiaceae show asymmetrical karyotype with these advanced characters and by the common occurrence of subterminal kinetochore show that this family may be considered as one of the most highly evolved family among Angiosperms.

Key words: Karyotype, asymmetrical, Euphorbiaceae, polyplody and evolution.

Introduction

Euphorbiaceae is popularly known as the spurge family. The family consists of 400 genera including 8000 species and one of the largest families of Dicotyledons. The majority of the taxa of Euphorbiaceae are distributed both in tropical and subtropical regions. There are eight species belonging to seven genera in Southern India (Gamble, 1957). Many workers have studied this family for cytological, cytology and cytogenetical investigations as well, but there has been limited research as far as the Southern Indian taxa concerned. An attempt is made in the present work to understand the cytotaxonomical relationship between the taxa of the family.

Polyplody or genomic multiplication is a common and continuous phenomenon in the evolution of plants (Adams and Wendel, 2005) and also about 70% of the angiosperms are polyploids (Leitch and Bennet, 1997). In general, polyploids are good colonizers (DeWet, 1980) and some invasive species considered as such, since they exhibit fast chromosomal evolutionary events (Reznick and Ghalambor, 2001). Also, the genomic reorganization and chromosomal repatterning that occur in polyploids (Schifino-Wittmann, 2004) can modify their tolerance to the environment (Lee, 2002).

Materials and Methods

The selected healthy fresh excised root tips were pre-treated in 0.002 M aqueous solution of 8-hydroxyquinoline kept at 4°C for 3 hours. After thorough washing the root tips were fixed in 1:3 acetic alcohol mixtures for at three hours or overnight. Then they were squashed following Mariimuthu and Subramanian (1960) iron alum haematoxylin squash schedule. Important plates were drawn with Abee’s Camera Lucida and some of them photographed. The chromosome numbers of taxa were determined in the present study and listed. (Table1).
Table 1
Chromosome numbers of the species investigated (Vide Fedorov 1974)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the species</th>
<th>Previous reports Authors</th>
<th>Present reports N o 2n</th>
<th>Present reports 2n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Euphorbia tirucalli Linn.</td>
<td>Tjio (1943), Mege (1930)</td>
<td>20</td>
<td>20</td>
</tr>
<tr>
<td>2.</td>
<td>Euphorbia splendens Boj.</td>
<td>Sugura 1933a, Bowden 1940a, Matsuura, Suto 1935</td>
<td>36</td>
<td>40</td>
</tr>
<tr>
<td>3.</td>
<td>Sauropus androgynus Merr.</td>
<td></td>
<td>24 (New report)</td>
<td></td>
</tr>
<tr>
<td>4.</td>
<td>Croton sparsiflorus Morong</td>
<td></td>
<td>64 (New report)</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Acathya indica Linn.</td>
<td>Thombe 1959b, Gajapathy 1961</td>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>8.</td>
<td>Excoecaria agallocha Linn.</td>
<td>Perry B.A. 1943</td>
<td>24</td>
<td></td>
</tr>
</tbody>
</table>

Results and Discussion

The chromosome count of eight species belonging to seven genera resolved in the present study are listed in the Table-1, which ranges from 2n=20 to 2n=72. First records of chromosome counts have been made in Sauropus androgynus and Croton sparsiflorus. Deviant chromosome number has been observed as against the previous report in Excoecaria agallocha. In the rest of the species, the present report of the chromosome numbers confirms the earlier record. The present report of diploid number in Euphorbia tirucalli confirms that of Tjio (1943), Mege (1930a); in Euphorbia splendens that of Sugura (1956a), Bowden (1940a), and Matsuura-Suto (1935); in Acathya indica that of Thombe (1959b) and Gajapathy (1961); in Ricinus communis that of Nemec (1910); Taylor (1926); Hagerup (1932); Doulat (1943); Perry (1943) and Day (1947); in Jatropha curcas that of Perry (1943) and Miller and Webster (1962); in Excoecaria agallocha that of Perry (1943).

Out of eight species studied here 2n=20 chromosomes have been observed in Euphorbia tirucalli. Acathya indica and Ricinus communis 2n=22 chromosomes have been observed in Jatropha curcas 2n=24 chromosomes have been observed in Sauropus androgynus 2n=40 chromosomes have been observed in Euphorbia splendens 2n=64 chromosomes have been observed in Croton sparsiflorus and 2n=72 chromosomes have been observed in Excoecaria agallocha (Fig-1, 2 and Table 2-10).

A common survey of the chromosome number in Euphorbiaceae reveals the existence of a graded series of haploid numbers; namely, 6, 7, 8, 10, 11, 12, 13, 14, 15, 16, 17, 18, 20, 21, 22, 24, 26, 28, 30, 36, 50, 72, 100, and 112 (so called Carex type and Antirrhinum type of Tischler, 1937). Suggesting an increase by a few chromosomes or by one chromosome. It is logical to assume the original primary basic number to be 10 which should have given rise to the derived primary basic number that is 20. In Euphorbiaceae, the highest frequency of haploid chromosome numbers that is 10, 11, and 13 are nearly equal (Vide Fedorov 1974) so it may be inferred that to 10 may be the original primary basic number and 11 and 13 the derived basic numbers. This fact would perhaps appear to suggest that the haploid number 10 may be considered as the primary basic number of this family, from which the other haploid numbers, high and low, might have been derived. Incase or decrease in chromosome numbers might be brought about by various karyological mechanisms.

Babcock (1947) and Ogby (1943) have reported in Crepis the progressive decrease in chromosome basic number from 6 to 3. In the present study, in the family Euphorbiaceae, a similar process of chromosome reduction to n=10, n=9 and finally to n=6 by a series of unequal translocation involving concurrent loss of inter heterochromatin part of the chromosomes have been noticed. The haploid numbers 6, 7, and 9 represent secondary basic number from which primary haploid numbers might have derived through aneuploidy or euploidy. This view is evidenced by statement of Heywood (1967) that in the plant kingdom, even 14 may be considered as a polyploid number in as much as that the herbaceous dicotyledons have been reported to show frequency of curves of n=7, 8, and 9.
Table 2

<table>
<thead>
<tr>
<th>S.No</th>
<th>Taxa</th>
<th>Absolute length in µm</th>
<th>Range in µm</th>
<th>Karyotype</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td><em>Euphorbia tirucalli</em></td>
<td>18.8</td>
<td>2.2 to 1.6</td>
<td>2n= 20= J₄+V₈+I₀</td>
<td>The present report confirms the earlier reports (figs-1A &amp; B)</td>
</tr>
<tr>
<td>2</td>
<td><em>Euphorbia splendens</em></td>
<td>40.0</td>
<td>2.5 to 1.6</td>
<td>2n= 40= J₄+J₆+V₁₈+I₁₀</td>
<td>The present report confirms the earlier reports (figs-1C &amp; D)</td>
</tr>
<tr>
<td>3</td>
<td><em>Sauropus androgynus</em></td>
<td>32.4</td>
<td>3.5 to 2.2</td>
<td>2n= 24= S₆+J₆+J¹+V₄</td>
<td>No record of chromosome number or karyotype study (figs-1E &amp; F)</td>
</tr>
<tr>
<td>4</td>
<td><em>Croton sparsiflorus</em></td>
<td>113.0</td>
<td>5.0 to 1.2</td>
<td>2n= 64= S₁₄+J₁₆+J¹₂+V₈+V₀</td>
<td>No record of chromosome number or karyotype study (figs-1G &amp; H)</td>
</tr>
<tr>
<td>5</td>
<td><em>Acaphya indica</em></td>
<td>41.2</td>
<td>5.5 to 3.2</td>
<td>2n= 20= S₄+J₄+J₄+V₂</td>
<td>The present report confirms the earlier reports (figs-2A &amp; B)</td>
</tr>
<tr>
<td>6</td>
<td><em>Ricinus communis</em></td>
<td>30.4</td>
<td>4.5 to 2.0</td>
<td>2n= 20= S₄+J₂+V₆</td>
<td>The present report confirms the earlier reports (figs-2C &amp; D)</td>
</tr>
<tr>
<td>7</td>
<td><em>Jatropha curcas</em></td>
<td>26.4</td>
<td>3.4 to 1.2</td>
<td>2n= 22= S₂+J₃₂+V₄+I₄</td>
<td>The present report confirms the earlier reports (figs-2E &amp; F)</td>
</tr>
<tr>
<td>8</td>
<td><em>Etcoecaria agallocha</em></td>
<td>84.2</td>
<td>3.0 to 0.5</td>
<td>2n= 72= S₁₄+J₁₆+J¹₂+V₈+V₁₂+I₁₀+B₄</td>
<td>The present report (2n= 72) differs from the earlier reports (2n= 24). (95% of the diploid cells have shown 2n= 72 and it was the new record of chromosome number (figs-2G &amp; H)</td>
</tr>
</tbody>
</table>

Table 3

<table>
<thead>
<tr>
<th>S.No</th>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>S/L ratio</th>
<th>Relative length of chromosome</th>
<th>Position of Centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>No</td>
<td>Total Length</td>
<td>Long arm</td>
<td>Short arm</td>
</tr>
<tr>
<td>1</td>
<td>J</td>
<td>4</td>
<td>2.2</td>
<td>1.6</td>
<td>0.6</td>
</tr>
<tr>
<td>2</td>
<td>V</td>
<td>8</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>I</td>
<td>8</td>
<td>1.6</td>
<td>1.2</td>
<td>0.4</td>
</tr>
</tbody>
</table>

The total chromosome length is: 37.60 µm
The absolute chromosome length is: 18.80 µm
The average chromosome length is: 1.88 µm
Figure 1. A & B. *Euphorbia tirucalli*: A) Metaphase $2n=20$ chromosome B) Anaphase C&D. *Euphorbia splendens*: C) Metaphase $2n=40$ chromosome D) Metaphase (variant stage) E&F. *Sauropus androgynus*: E) Metaphase $2n=24$ chromosome F) Metaphase showing different chromosome configuration G&H. *Croton sparsiflorus*: G) Anaphase H) Metaphase $2n=64$ chromosome
Figure 2 A&B. *Acalypha indica*: A) Metaphase $2n=20$ chromosome B) Metaphase showing different chromosome configuration C&D. *Ricinus communis*: C) Pro metaphase $2n=20$ chromosome D) Metaphase $2n=20$ chromosome E&F: *Jatropha curcas*: E) Metaphase $2n=22$ chromosome F) Metaphase showing different chromosome configuration G&H. *Excoecaria agallocha*: G) Metaphase $2n=72$ chromosome H) Metaphase showing different chromosome configuration $2n=72$ chromosomes.
TABLE - 4
*Euphorbia splendens* Boj
The somatic chromosome number has been observed to be $2n=40$

<table>
<thead>
<tr>
<th>S.No</th>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>S/L ratio</th>
<th>Relative length of chromosome</th>
<th>Position of Centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>No</td>
<td>Total Length</td>
<td>Long arm</td>
<td>Short arm</td>
</tr>
<tr>
<td>1</td>
<td>J</td>
<td>4</td>
<td>2.5</td>
<td>2.0</td>
<td>0.5</td>
</tr>
<tr>
<td>2</td>
<td>J¹</td>
<td>8</td>
<td>2.2</td>
<td>1.8</td>
<td>0.4</td>
</tr>
<tr>
<td>3</td>
<td>V</td>
<td>18</td>
<td>2.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>I</td>
<td>10</td>
<td>1.6</td>
<td>1.4</td>
<td>0.2</td>
</tr>
</tbody>
</table>

The total chromosome length is: 79.6 µm; The absolute chromosome length is: 400 µm; The average chromosome length is: 20 µm

TABLE - 5
*Saurops androgynus* Merr.
The somatic chromosome number has been observed to be $2n=24$

<table>
<thead>
<tr>
<th>S.No</th>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>S/L ratio</th>
<th>Relative length of chromosome</th>
<th>Position of Centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>No</td>
<td>Total Length</td>
<td>Long arm</td>
<td>Short arm</td>
</tr>
<tr>
<td>1</td>
<td>S</td>
<td>6</td>
<td>3.5</td>
<td>2.5</td>
<td>1.0</td>
</tr>
<tr>
<td>2</td>
<td>J</td>
<td>2</td>
<td>2.8</td>
<td>2.0</td>
<td>0.8</td>
</tr>
<tr>
<td>3</td>
<td>J¹</td>
<td>6</td>
<td>2.5</td>
<td>2.0</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>V</td>
<td>6</td>
<td>2.4</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>5</td>
<td>V¹</td>
<td>4</td>
<td>2.2</td>
<td>1.1</td>
<td>1.1</td>
</tr>
</tbody>
</table>

The total chromosome length is: 64.8 µm; The absolute chromosome length is: 32.4 µm; The average chromosome length is: 1.3 µm

TABLE - 6
*Croton sparsiflorus* Mbrong.
$2n=64$ Chromosomes have been observed in the root tip cells of this species.

<table>
<thead>
<tr>
<th>S.No</th>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>S/L ratio</th>
<th>Relative length of chromosome</th>
<th>Position of Centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>No</td>
<td>Total Length</td>
<td>Long arm</td>
<td>Short arm</td>
</tr>
<tr>
<td>1</td>
<td>S</td>
<td>14</td>
<td>5.0</td>
<td>3.5</td>
<td>1.5</td>
</tr>
<tr>
<td>2</td>
<td>J</td>
<td>16</td>
<td>3.8</td>
<td>2.8</td>
<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>J¹</td>
<td>12</td>
<td>3.2</td>
<td>3.2</td>
<td>1.0</td>
</tr>
<tr>
<td>4</td>
<td>V</td>
<td>8</td>
<td>3.0</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>5</td>
<td>V¹</td>
<td>10</td>
<td>2.8</td>
<td>1.4</td>
<td>1.4</td>
</tr>
<tr>
<td>6</td>
<td>I</td>
<td>4</td>
<td>1.2</td>
<td>1.0</td>
<td>0.2</td>
</tr>
</tbody>
</table>

The total chromosome length is: 226.00 µm; The absolute chromosome length is: 113.00 µm; The average chromosome length is: 3.5 µm
The somatic chromosome number has been observed to be \(2n = 20\)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>S.L ratio</th>
<th>Relative length of chromosome</th>
<th>Position of Centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>No</td>
<td>Total length</td>
<td>Long arm</td>
<td>Short arm</td>
</tr>
<tr>
<td>1</td>
<td>S</td>
<td>4</td>
<td>5.5</td>
<td>3.5</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>J</td>
<td>4</td>
<td>4.0</td>
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<td>1.0</td>
</tr>
<tr>
<td>3</td>
<td>J'</td>
<td>4</td>
<td>3.5</td>
<td>2.5</td>
<td>0.5</td>
</tr>
<tr>
<td>4</td>
<td>V</td>
<td>6</td>
<td>4.0</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>5</td>
<td>V'</td>
<td>6</td>
<td>3.2</td>
<td>1.6</td>
<td>1.6</td>
</tr>
</tbody>
</table>

The total chromosome length is: 82.4µm; The absolute chromosome length is: 41.2µm
The average chromosome length is: 4.1µm

### TABLE - 8

*Ricinus communis* Linn.

2\(n = 20\) Chromosomes have been observed in the root tip cells of this species

<table>
<thead>
<tr>
<th>S. No</th>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>S.L ratio</th>
<th>Relative length of chromosome</th>
<th>Position of Centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Type</td>
<td>No</td>
<td>Total length</td>
<td>Long arm</td>
<td>Short arm</td>
</tr>
<tr>
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<td>S</td>
<td>4</td>
<td>4.5</td>
<td>2.5</td>
<td>2.0</td>
</tr>
<tr>
<td>2</td>
<td>J</td>
<td>2</td>
<td>3.4</td>
<td>3.0</td>
<td>0.4</td>
</tr>
<tr>
<td>3</td>
<td>V</td>
<td>8</td>
<td>3.0</td>
<td>1.5</td>
<td>1.5</td>
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<tr>
<td>4</td>
<td>V'</td>
<td>6</td>
<td>2.2</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

The total chromosome length is: 60.8µm; The absolute chromosome length is: 30.4µm
The average chromosome length is: 3.0µm

### TABLE - 9

*Jatropha curcas* Linn.

The somatic chromosome number has been observed to be \(2n = 22\)

<table>
<thead>
<tr>
<th>S. No</th>
<th>Chromosome</th>
<th>Chromosome length in µm</th>
<th>S.L ratio</th>
<th>Relative length of chromosome</th>
<th>Position of Centromere</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td>Total length</td>
<td>Long arm</td>
<td>Short arm</td>
</tr>
<tr>
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<tr>
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<td>S'</td>
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<td>3.0</td>
<td>2.0</td>
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<tr>
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<tr>
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<td>V'</td>
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</tr>
<tr>
<td>6</td>
<td>I</td>
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<td>0.4</td>
</tr>
</tbody>
</table>

The total chromosome length is: 52.8µm; The absolute chromosome length is: 26.4µm
The average chromosome length is: 2.4µm
Chromosome reduction has been observed among the given rise to derived primary basic number 11 and 13. Chromosome reduction has been observed among the species of Crepis in which the basic number 10 might have got reduced to n=9 and finally to n=6 by a series of unequal translocation involving concurrent loss of inert heterochromatin part of the chromosomes. The other highest haploid number above the level of n=10 should have arose by means of aneuploidy and euploidy.

In the present study, critical karyotype of as many as eight species of Euphorbiaceae show asymmetrical karyotype. With this advanced character and by the common occurrence of subterminal kinetochore in the family, it may be considered as one of the highly evolved family of Angiosperms.

### Conclusion

The chromosome numbers of eight species belonging to seven genera of Euphorbiaceae from Southern India has been studied. The chromosome numbers ranged from 2n=10 to 2n=72. First record of chromosomes number have been made from two species and deviant record of chromosome number as against the previous report has been worked out in one species. In the rest of the species studied the present report of chromosome numbers confirms the previous record.

A common survey of the chromosome number in Euphorbiaceae reveals the existence of haploid number from 6 to 112. 0f those haploid number n=10, n=11 and n=13 represented the highest frequency among the taxa studied. Therefore, it may be assumed that the original primary basic number may be 10 and it should have given rise to derived primary basic number 11 and 13. Chromosome reduction has been observed among the species of Crepis in which the basic number 10 might have got reduced to n=9 and finally to n=6 by a series of unequal translocation involving concurrent loss of inert heterochromatin part of the chromosomes. The other highest haploid number above the level of n=10 should have arose by means of aneuploidy and euploidy.

### References


### Acknowledgements

The authors are thankful to the authorities of A nnamalai U niversity and D r. R. Panneerselvam, D ean F aculty of Sciences, Professor and H ead, D epartment of B otany, A nnamalai U niversity, T amil N au d, I ndia for having provided laboratory facility and encouragements.