OBSERVATIONS

Genus: Euphorbia L.
Section 1: Anisophyllum

Plants herbs, rarely shrubby below, prostrate or ascending. Leaves all opposite, oblique or unequal at the base, stipulate or connected by a stipular line. Involucres solitary or cymose, glands 4-5, usually furnished with a petaloid limb.

1. E. clarkeana Hook.f.

A common weed in the cultivated fields of northwestern India extending from Delhi westward to Amritsar. Flowers: August-November.

The present count of n=11 at diakinesis (Fig.1) is the first report of the chromosome number in this taxon. The meiosis was perfectly normal resulting in fertile pollen.

2. E. aeniculata Orteg.

This species originally a native of tropical America,
grows in our part of the country in cultivated fields and gardens, ascending up to 1500 M.

Flowers: May-November.

The present count of n=14 at M-I (Fig.2) confirms the earlier reports by Moyer (1934) and Datta (1967). Of the 14 bivalents observed at M-I, one showed precocious disjunction. The disjoined partners lie some distance apart. Another bivalent also showed a similar tendency towards early separation.

3. E. heterophylla L.

This species, a native of North America, is cultivated in the gardens. It is also found as an escape.

Flowers: September-March.

Type A. The Amritsar population of this species showed 28 chromosomes at each pole of A-I (Fig.3). Meiosis was perfectly normal, resulting in 100% pollen fertility. Moyer (1934), Perry (1943) and Diers (1961) reported the same chromosome number for some other populations of this species. This taxon may be considered as an octaploid based on x=7.

Type B. A cytological survey of Chandigarh population of this species persistently gave a count of 27 at M-I (Fig. 4). Sharma (1955) reported n=27 and 2n=54 for this species. On the basis of the present data,
it seems that the Chandigarh population may be a hypo-octaploid derived from the octaploid by the loss of two chromosomes.

A morphological comparison of the two cytologically variable populations did not show any significant morphological differences to warrant any particular status for these variants.

4. *E. microphylla* Heyne

It is distributed throughout the plains of India and occurs in Bengal, Bihar and Panjab as a weed of lawns.

Flowers: August-December.

The present count, n=14, at diakinesis (Fig. 5) differs from that of Chopde (1965) (2n=20). The meiosis was found to be perfectly normal resulting in well filled pollen grains.

5. *E. hirta* L.

It is distributed in all tropical and sub-tropical countries. In India it is met throughout the hotter parts from the Panjab eastwards.

Flowers: Greater part of the year.

Nine bivalents were observed at M-I (Fig. 6). The meiosis was found to be regular resulting in normal pollen fertility. Sharma and Jash (1958), Datta (1967) and Gill et al (1970) also reported the same chromosome
number for this species. Raghvan and Arora (1958), however, reported $2n=20$ and Chopde (1965) $2n=12$ for some other Indian populations of this species. The occurrence of divergent chromosome numbers in this species suggests that this taxon exists in several cytological forms. A careful morphological study is needed to see whether or not this divergence in chromosome numbers is accompanied with any morphological alterations.


This is the most common species out of the small-leaved forms of the genus met with in the Panjab plains.

Flowers: Major part of the year.

At M-I (Fig. 7) 9 bivalents were observed. The meiosis was normal resulting in 100% pollen fertility. Datta (1967) reported the same chromosome number in this species. Murin and Chaudhri (1970) have, however, reported $2n=20$ from Iraqi populations of this species.


It is cultivated under the popular name of Poinsettia. It came originally from Mexico and was named after ambassador Poinsett of South Carolina, who brought first plants from there in the middle of 19th century. The upper floral leaves are brightly coloured, crimson or yellowish-white.

Flowers: September-March.
At M—I (Fig. 8) 14 bivalents were clearly observed. Six of these showed a tendency towards early disjunction. Moyer (1934) reported the same chromosome number in this species. Ewart and Walker (1960), however, found $2n=28$ and $2n=56$ from different cultivars of this species. The former taxon may be considered as a tetraploid and the latter an octaploid based on $x=7$.

8. *E. thymifolia* Burm.

Distributed throughout India in the plains and lower hills, ascending in Kashmir up to 2000 M. Common in waste places.

Flowers: Almost throughout the year.

The present count of $n=9$ at M—I (Fig. 9) confirms an earlier report by Datta (1967). Meiosis was found to be normal resulting in 100% pollen fertility.

Section 2: Euphorbium

Shrubs or trees (except in sub-section *Rhizanthium* where the stem is reduced to a fleshy tuber with short unarmed branches) with fleshy terete, ribbed, angled or flattened stems and branches. Leaves absent or alternate when present or the upper opposite; stipules absent or glandular or of prickles. Involucres axillary or terminal or in forks, often sessile, rarely cymose, glands without
a petaloid limb.

9. *E. antiquorum* L.

Occurs throughout the hotter parts of India, ascending to 700 M.

Flowers: March-May.

Previously this species did not receive any cytological attention. Presently at diakinesis (Fig. 10) 30 bivalents were clearly counted. There was normal meiosis preceding the formation of fertile pollen grains.

10. *E. nemifolia* L.

It is common in rocky places of Deccan Peninsula, often planted for hedges.

Flowers: March-May.

Meiotic studies were made from flower buds collected from two different morphotypes. Both showed abnormal meiosis with 2n=90. A comparative account of the morphological differences in these two populations, one from Chandigarh and the other from Ahmedabad, is given in Table 2. It may be stated that both have been planted in the University Botanical Gardens under uniform environmental conditions.
Type A (Chandigarh). The chromosome number 2n=90 (Fig. 14) was determined from pollen mother cells. The meiosis was observed to be highly abnormal as evidenced by the types of chromosome associations given in Table 3. Laggards were observed at A-I (Fig. 15) reducing the well filled pollen to only 15%. A late M-I (Fig. 16) showed that all but 8 bivalents have disjoined. Formation of micropollen was also observed. Seed formation was completely absent. In this taxon, very rarely, a spore mother cell could be seen with 90 II at M-I (Fig. 17). Not unoften bivalents were observed to form chains of variable length (Fig. 18).
TABLE - 3

Chromosome configuration at M-I in ten different cells.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
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<td>12</td>
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<tr>
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<tr>
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<td>16</td>
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<td>3</td>
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<td>4</td>
<td>9</td>
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<tr>
<td>9</td>
<td>17</td>
<td>13</td>
<td>6</td>
<td>2</td>
<td>3</td>
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</tr>
<tr>
<td>10</td>
<td>17</td>
<td>11</td>
<td>6</td>
<td>3</td>
<td>3</td>
<td>1</td>
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<tr>
<td><strong>Total</strong></td>
<td>217</td>
<td>142</td>
<td>61</td>
<td>34</td>
<td>12</td>
<td>5</td>
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</table>

Type B (Ahmedabad). Chromosome number in this taxon too was 2n=90 (Fig. 19) as ascertained from pollen mother cells. The chromosome associations as observed at diakinesis are given in Table 4. Laggards were observed at A-I (Fig. 20). As in the preceding population, micropollen were also observed. Pollen sterility was about 78%. There was no seed set at all. Sharma and Jash (1958) and Datta (1967) recorded 2n=60 and Gill et al (1970) 2n=80 for some other Indian populations of
this species. The occurrence of different chromosome numbers in this species indicates the existence of several cytological races in this taxon.

**TABLE - 4**

Chromosome configurations at M-I in ten different cells.

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>I</th>
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<th>III</th>
<th>IV</th>
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<th>VI</th>
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<td>3</td>
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</tr>
<tr>
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<td>19</td>
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<td>-</td>
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<tr>
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<td>22</td>
<td>4</td>
<td>-</td>
<td>2</td>
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</tr>
</tbody>
</table>

Total 167 198 40 31 9 8

11. *E. nivulis* Han.

Occurs in north-west Himalayas, on dry rocky hills in Rajasthan and Gujrat.

The chromosome number of this species was not known previously. Thirty bivalents were observed at
diakinesis (Fig. 21). The diad and tetrad stages were found to be normal which resulted in 100% pollen fertility.

12. *E. royleana* Boiss.

The species commonly occurs in outer Himalayas in dry hilly tracts from Kumaon to Jhelum ascending up to 2000 M.

Flowers: March-May.

At A-I (Fig. 22) 60 chromosomes were observed at each pole. Diad and tetrad formation was normal resulting in 100% fertile pollen. Bhalla (1941b), however, has reported $2n=30$ for this taxon.


The species is native of Madagascar and is grown as an ornamental.

Flowers: Major part of the year.

At diakinesis (Fig. 23) 20 bivalents were clearly observed. Meiosis was found to be normal resulting in the formation of fully fertile pollen grains. The same chromosome number has also been reported by Harrison (1930) and Matsuura (1935) (cf. Perry, 1943), and Datta (1967). Suguir (1935) (cf. Perry, l.c.), however, reported $2n=36$ in this species. Gill *et al* (1970) have also reported $n=21$ for another Indian population of this species.
Section 3 : Tithymallus

Herbs, rarely shrubby below, usually erect, branches terete, not fleshy. Leaves alternate, upper (rarely all) opposite, exstipulate. Involucres in terminal or axillary cymose umbels radiating in threes; glands without a petaloid limb.

14. **E. dracunculoides** Lamk.

A weed of cultivated fields, extends from Panjab to Bihar in the plains and low hills.

Flowers: March-May.

At diakinesis (Fig. 24) 8 bivalents were clearly counted. All the stages of meiosis were normal resulting in 100% pollen fertility. Malik (1960) also reported the same chromosome number in some other Indian population.

15. **E. helioscopia** L.

A common weed of gardens which occurs in Panjab plains and extends in the western Himalayas up to 2700 M. It is also distributed in west Asia and Europe.

Flowers: December-April in plains and May in hills.

At M-I (Fig. 25) 21 bivalents were counted. The meiosis was found to be normal resulting in 100% pollen fertility. The chromosome count for this species has been confirmed from the populations of Panjab plains (Amritsar and Chandigarh) as well as from Srinagar (Kashmir, alt.
2000 M). This confirms the earlier reports by Harrison (1930), Perry (1943) and Shimoyama (1958). However, Harrison (l.c.) also reported a cytotype with 2n=18, while Nemec (cf. Perry, 1943) found another with 2n=12.

16. **E. maddeni** Boiss.

It is distributed in the western Himalayas, extending up to 3000 M in Kashmir. It is popularly known as 'Gurswachal' by the local people.

Flowers: May–June.

The chromosome number, n=8 in this species is reported for the first time. At A-I (Fig. 26) 8 chromosomes were observed at each pole. Meiosis was found to be normal resulting in 100% pollen fertility.

17. **E. pilosa** L.

It occurs in western Himalayas and is common in Simla and Mussoorie.

Flowers: May–July.

At diakinesis (Fig. 27) pollen mother cells showed 16 II. The chiasma were both terminal and interstitial. Meiosis was perfectly normal resulting in 100% pollen fertility. Perry (1943), however, found 2n=18 in this species from plants grown in the botanical garden, Cambridge (England).

It is distributed in the western and central Himalayas, ascending above 2700 M, common in Khilan marg (Kashmir) where it forms a pure and large association.

Flowers: July-August.

The chromosome number of this species was not known previously. Ten chromosomes were clearly counted at each pole at A-I (Fig. 28). Meiosis was found to be normal and pollen 100% fertile.
Fig. 21. A-F. *E. dracunculoides*, megasporogenesis and female gametophyte.

A. Vertical section of a portion of nucellus showing periclinal division in the archesporial cell. x 800

B. Same, showing deep-seated megaspore mother cell. x 800

C. A linear tetrad. x 1400

D-F. Two-, 4- and 8-nucleate embryo sacs. x 1400

G. A portion of the embryo sac; note the male nucleus inside the nuclear membrane of secondary nucleus. x 1400
Fig. 20. A–K. *E. dracunculoides*, microsporangium, microsporogenesis and male gametophyte.

A. T.S. portion of anther showing two archesporial cells. x 1400

B. Same, showing anther wall, uninucleate tapetum and sporogenous tissue. x 1400

C, D. Same, showing different stages in the development of anther; note binucleate tapetum in C, degenerated middle layer, degenerating tapetal cells, and tetrahedral microspore tetrads in D. x 1400

E. Same, showing degenerated tapetum and microspores. x 800

F. A portion of anther wall showing mature endothecial cells and stretched epidermal cells. x 1400

G–K. Stages in the development of male gametophyte leading to the formation of trinucleate pollen grains. x 1400
Fig. 9. *E. thymifolia*, nine bivalents at MI. x 2400

Fig. 10. *E. antiquorum*, PMC at diakinesis showing 30 bivalents. x 1400

Figs. 11-13. *E. neriifolia*

Fig. 11. a. Plant showing spirally ribbed stem (Chandigarh)
    b. Plant exhibiting cylindrical stem (Ahmedabad)

Fig. 12. a. Oblong spathulate leaf of Chandigarh morphotype.
    b. Ovate leaf of morphotype from Ahmedabad.

Fig. 13. Part of a stem showing arrangement of cyathia in Chandigarh morphotype (a) and Ahmedabad morphotype (b).
Figs. 14-18. *E. neriifolia* (Chandigarh morphotype)

Fig. 14. PMC with $2vI+1vI+2vII+6vIII+14vII+13$ at M I. $x 1400$

Fig. 15. Laggards at A I. $x 1400$

Fig. 16. PMC at late M I with most of the bivalents disjoined. $x 1400$

Fig. 17. PMC with 90 bivalents at M I. $x 1400$

Fig. 18. Bivalents forming chains of variable length. $x 1400$

Fig. 19. *E. neriifolia* (Ahmedabad morphotype) PMC at diakinesis with $1vI+3vIII+25vII+26vI. x 1400$