BULL. BOT. SURV. INDIA
Vol. 2, Nos. 3 & 4: pp. 299-303, 1960

MORPHOLOGICAL AND CYTOLOGICAL STUDIES IN THE GENUS *LANTANA* L.

R. S. RAGHAVAN AND C. M. ARORA
Central Botanical Laboratory, Botanical Survey of India, Allahabad

ABSTRACT

1. Chromosome numbers in *L. wightiana* and *L. montevidensis* have been recorded for the first time. These plants have a basic number of n=12 which is the same for all the species studied so far except *L. camara*.

2. Of the plants studied, polyploid races were observed in *L. camara* var. *mutabilis* only. In this variety there is no correlation between flower colour and chromosome number. In nature tetraploids and to a lesser extent triploids are predominant.

3. Stomata are confined to lower epidermis only. The number of stomata per square millimetre varies at the species level, but is more or less constant in all the three varieties and polyploid races of *L. camara*. The diploid forms of all the three varieties of *Lantana camara* have smaller stomata when compared to the higher polyploids.

4. In all the plants studied, 4-8 microspores were found due to laggards forming small micro-nuclei.

5. In spite of a regular meiosis in *L. camara* var. *nivea* and *Lantana montevidensis* pollen grains were found to be completely sterile. Conversely, in spite of irregular meiosis in some of the triploids of var. *mutabilis*, pollen fertility was very high. In var. *crocea* partial sterility prevails, though meiosis is normal. Sterility in *Lantana* is not merely due to chromosomal aberrations but is also gene controlled.

6. Even completely male sterile species produced viable seeds. Preliminary studies seem to indicate the prevalence of apomixis in this genus.

The genus *Lantana* though originally a native of America, is at present distributed in the warmer parts of America, Asia and Africa. Bailey (1944) has listed about 75 species for this genus, but it is very difficult to assign the different morphological forms to the various species. A few species are of horticultural value because of the attractive flowers, and at times *Lantana camara* is used as a hedge plant. To-day, *Lantana camara* has run wild in both the waste and cultivated land so much so that its eradication has become a major concern to the Agricultural and Forest Departments.

In spite of the large number of species, only a very few species have received the attention of cytologists and most of the work is confined to *Lantana camara* only. Cytological studies by Singh (1951), Tandon & Bali (1955) and Sen and Sahni (1955) have revealed the existence of polyploid forms in *L. camara* with numbers ranging from 2n=22 to 55 but it was Natarajan and Ahuja (1957) who undertook a cyto-taxonomic survey of the genus for the first time. According to their findings, the genus *Lantana* is di-basic with the basic numbers x=11 limited to *L. camara* only, whereas all the other species studied so far have a basic number of x=12. In *Lantana camara* the polyploids exhibited a wide range from 2n=22 to 2n=66, and this was manifested in var. *mutabilis* only. The remaining species of *Lantana*, that have been studied are *Lantana trifolia* (2n=48, Patermann 1938), *L. lilacina* Desf. (2n=36), *L. involucrata* L. (2n=36) and *L. indica* Roxb. (2n=72) by Natarajan & Ahuja.

In the course of the present studies, *L. wightiana* Wall. and *L. montevidensis* Briq. have been studied for the first time. Besides the above two species, *L. indica* Roxb. and three varieties of *L. camara* viz. var. *nivea* Bailey, var. *crocea* Bailey and var. *mutabilis* Bailey have also been examined in detail. The plants were collected from different localities as Calcutta, Allahabad, Lucknow, Dehra Dun, Bombay, Nandi Hills, Coimbatore and Nilgiris. Though extensive observations were made, only relevant data and details not dealt with by earlier workers have been included in this paper.

Lantana wightiana Wall. is a small unarmed shrub, about 2 to 3 ft. tall growing wild in the scrub jungles of Therkumalai, near Coimbatore. The leaves are small, ovate, covered with soft villous or tomentose hairs and the flowers are of a dull white colour with prominent bracts and bracteoles. All the nine plants examined for this species revealed a somatic number of 2n=72 (Fig. 11) which is a first count for this species. Mature anthers are black, shrivelled up, and pollen grains completely sterile.

L. montevidensis Briq. collected from Bombay and Nilgiris is generally cultivated for its beautiful purple flowers. The plant has a spreading habit, glabrous and is unarmed. All the seven plants examined had 2n=36 chromosomes (Fig. 10), which has been recorded for the first time. 18 bivalents are regularly formed at Metaphase I (Fig. 9) and meiosis is normal.

L. indica Roxb. collected from Bombay and Nandi Hills is found growing wild. All the 6 plants examined had 2n=72 chromosomes and at metaphase I, 36 bivalents were counted which is in accordance with previous observations.

In *L. camara*, as many as 80 plants collected from the different localities were studied to observe the relative frequency of the polyploid forms within the varieties, and to observe whether any definite correlation existed between flower colour and chromosome number. In var. *crocea* Bailey, though the flower colour exhibited a wide range from pale yellow to deep yellow, all the 18 plants examined were found to be only diploids with n=11 and 2n=22. Similarly all the 14 plants examined for var. *nivea* Bailey had a haploid number of n=11 only (Fig. 7), thus confirming the absence of polyploidy in these two varieties. In var. *mutabilis* Bailey the colour of the flowers showed a wide range from orange, red, purple, rose and yellow to an admixture of those colours in varying proportions. Of the 47 plants examined for this variety only 2 were diploids, 15 triploids and 30 tetraploids. In nature tetraploids and to a lesser extent triploids were most abundant, whereas the dwarf and stunted diploids were very rare. There was no correlation between flower colour and polyploidy in this variety as the triploids and tetraploids were represented fairly well, in all the various colours.

Epidermal peelings of the various species and varieties of *Lantana* as also the polyploid races within var. *mutabilis* were studied to have a comparative picture (Figs. 1-6).

The epidermal peeling of *Lantana wightiana* is characteristic because of the long villous hairs present in the leaves (Fig. 6).

TABLE I: A COMPARATIVE STUDY OF EPIDERMAL PEELINGS IN *LANTANA*

Ser. No.	Name	Locality	Flower colour	Ch. No.	No. of stomata *in upper* epidermis	No. of stomata *in lower* epidermis	Stomata per sq. mm.	Stomatal size
1	2	3	4	5	6	7	8	9
1.	*L. camara* var. *crocea*	Lucknow	Yellow	2n=22	1	40	320	31μ×20μ
2.	*L. camara* var. *nivea*	Lucknow	White	2n=22	1	42	320	31μ×19μ
3.	*L. camara* var. *mutabilis*	Coonoor	Orange Yellow	2n=22	2	43	324	31μ×20μ
4.	*L. camara* var. *mutabilis*	Lucknow	Rose	2n=33	1	42	320	35μ×23μ
5.	*L. camara* var. *mutabilis*	Coonoor	Deep red	2n=33	1	42	325	35μ×23μ
6.	*L. camara* var. *mutabilis*	Lucknow	Pale rose	2n=33	—	40	320	35μ×23μ
7.	*L. camara* var. *mutabilis*	Aurangabad	Scarlet	2n=44	1	42	320	35μ×24μ
8.	*L. camara* var. *mutabilis*	Coimbatore	Red	2n=44	1	40	316	35μ×24μ
9.	*L. montevidensis*	Coonoor	Pink	2n=36	—	28	230	27μ×18μ
10.	*L. wightiana*	Coimbatore	Dull white	2n=72	3	42	340	27μ×24μ
11.	*L. indica*	Nandi Hills	Pinkish to purplish	2n=72	1	35	280	27μ×24μ

From a study of Table I, it is evident that the upper epidermis is almost non-stomatiferous, the stomata being confined to lower epidermis only. The number of stomata per sq. mm. is more or less constant in all the three varieties of *Lantana camara* irrespective of the chromosome number. *L. montevidensis* has the lowest number of stomata per sq. mm. followed by *L. indica* but in *L. wightiana*, the number is slightly higher than that of *L. camara*. Measurement of stomatal size in all the plants showed that in general *L. camara* has larger stomata than the other species. Within *L. camara*, there is not much variation in the size of the stomata of the triploid and tetraploid forms of var. *mutabilis*, but the diploid forms of all the three varieties have smaller stomata as compared to the triploids and tetraploids.

A detailed study of meiosis in *Lantana* reveals two interesting features. In the first place 4-8 microspores were always formed in all the plants studied, without any exception. Secondly pollen fertility and seed setting were not always correlated with each other, and in some species were even independent of the other. The formation of more than 4 spores in triploids and tetraploids can be easily explained on the basis of multivalent formations and irregular separation of the chromosomes to the two poles resulting in laggards forming many micronuclei. However, it was observed that even in those plants with a regular meiosis (e.g. *L. montevidensis*, *L. indica*, *L. camara* var. *nivea*, var. *crocea* and diploid forms of var. *mutabilis* etc.) some laggards were present at anaphase II which accounted for more than four microspores.

It is interesting to study pollen fertility in relation to meiotic features and correlate pollen fertility with seed setting. In table II, a detailed analysis of pollen size, pollen fertility and seed setting in all the species and varieties studied is presented.

TABLE II: POLLEN STUDY AND SEED SETTING IN *LANTANA*

Name	Ch. No.	Percentage of Pollen fertility	Pollen Size		Seed setting
L. camara var. *nivea*	2n=22	Nil	Sterile grains	16μ—32μ (aver. 23μ)	Fair
L. camara var. *crocea*	2n=22	48% to 52%	Fertile grains	27μ—40μ (aver. 36μ)	Good
			St. Gr.	10μ—30μ (aver. 17μ)	
L. camara var. *mutabilis*	2n=22	78%	Fert. Gr.	31μ—43μ (aver. 35μ)	Very Good
			St. Gr.	10μ—25μ (aver. 17μ)	
-do-	2n=33	47%	Fert. Gr.	23μ—46μ (aver. 38μ)	Good
			St. Gr.	12μ—25μ (aver. 17μ)	
-do-	2n=44	65% to 90%	Fert. Gr.	35μ—52μ (aver. 43μ)	Seed setting better than the triploids and is very good
			St. Gr.	12μ—30μ (aver. 17μ)	
L. montevidensis	2n=36	Nil	St. Gr.	12μ—27μ (aver. 23μ)	Nil
L. wightiana	2n=72	Nil	St. Gr.	16μ—32μ (aver. 23μ)	Profuse in Nature
L. indica	2n=72	80%	Fert.	30μ—42μ	Very good

Pollen fertility is closely inter-related with meiotic details and in general the more regular the meiosis, the greater the fertility. In *Lantana*, one finds at least 3 different types.

In the first type as in *Lantana indica* and the diploid forms of var. *mutabilis*, the high percentage of pollen fertility is consistent with the normal meiosis and naturally seed setting is also very good in these forms. In the triploid and tetraploid forms of var. *mutabilis*, pollen fertility ranged from 47% to 90% depending on the degree of multivalent associations formed and mode of separation of the chromosomes to the two poles. In two tetraploid forms of this variety as many as 10 quadrivalents were formed on an average and because of the regular 2-2 separation of the chromosomes pollen fertility was nearly 90% and consequently good seed formation. Tetraploids were found to have better seed setting than triploids which is according to expectations.

In the second type, in spite of a regular meiosis, pollen sterility is complete. Though meiotic details in var. *crocea* and var. *nivea* are very similar, pollen fertility varies from 48% to 52% in the former whereas in the latter pollen grains are completely sterile. In *L. montevidensis*, 18 bivalents are regularly formed and at metaphase II, 18 chromosomes could clearly be counted. Nevertheless pollen grains were found to be inviable. The extreme is reached in *L. wightiana*, where the anthers are poorly developed, shrunk and black in colour with the pollen grains completely shrivelled up and empty. All the above plants produced viable seeds, the only exception being *L. montevidensis* where seed formation has not been observed so far. In the third type, as in some of the triploids of var. *mutabilis*, in spite of a very irregular meiosis, fertility and seed setting were found to be rather very high. It appears that pollen fertility in *Lantana* is not due to chromosomal aberrations only, but is also gene controlled. This will also explain the reason of reduced fertility in var. *crocea* where in spite of a normal meiosis, nearly half the grains are pollen sterile.

Seeds collected from the male sterile plants of *L. camara* var. *nivea* and *L. wightiana*, as also from the partially fertile triploid and tetraploid forms of var. *mutabilis* were sown in the month of June on ordinary sand mixed with leaf mould. Though the observations are only preliminary, the results are significant. The experiment is being repeated with the seeds of all the available species and varieties.

TABLE III: GERMINATION STUDIES IN *LANTANA*

S. No.	Name	Seeds sown	Seeds germinated	Chromosome Numbers of the Seedlings.	Remarks.
1.	*Lantana camara* var. *mutabilis* (3 x)	50	14	All had 2n=33 chromosomes.	Plants were identical to the mother with respect to general morphological features.
2.	*L. camara* var. *mutabilis* (4 x)	50	28	All the 8 plants examined had 2n=44 chromosomes.	
3.	*L. camara* var. *nivea* (2n=22)	50	6	All had 2n=22 chromosomes.	
4.	*L. wightiana*	50	32	Only 12 plants examined; but all had the same number of 2n=72 chromosomes.	

A study of the table reveals that the seedlings have the same chromosome number as the parents. Besides in flower colour and other features, the resemblance to the mother plant is striking. The production of seeds from completely male sterile plants and the resemblance of the offspring to the mother seems to indicate that apomixis is possibly prevalent in the genus. It is however too early to suggest the exact mechanism involved, which can be assessed only after a critical study of the megasporogenesis and embryology.

ACKNOWLEDGEMENT

We express our sincere thanks to Dr. G. S. Puri, M.Sc. HONS. (Punjab), Ph.D. (Luck.), Ph.D. (London), F.G.S., F.G.M.S., F.B.S., F.L.S. (London), F.A.Sc., Director, Central Botanical Laboratory, Allahabad, for kindly going through the paper and making valuable suggestions and criticisms.

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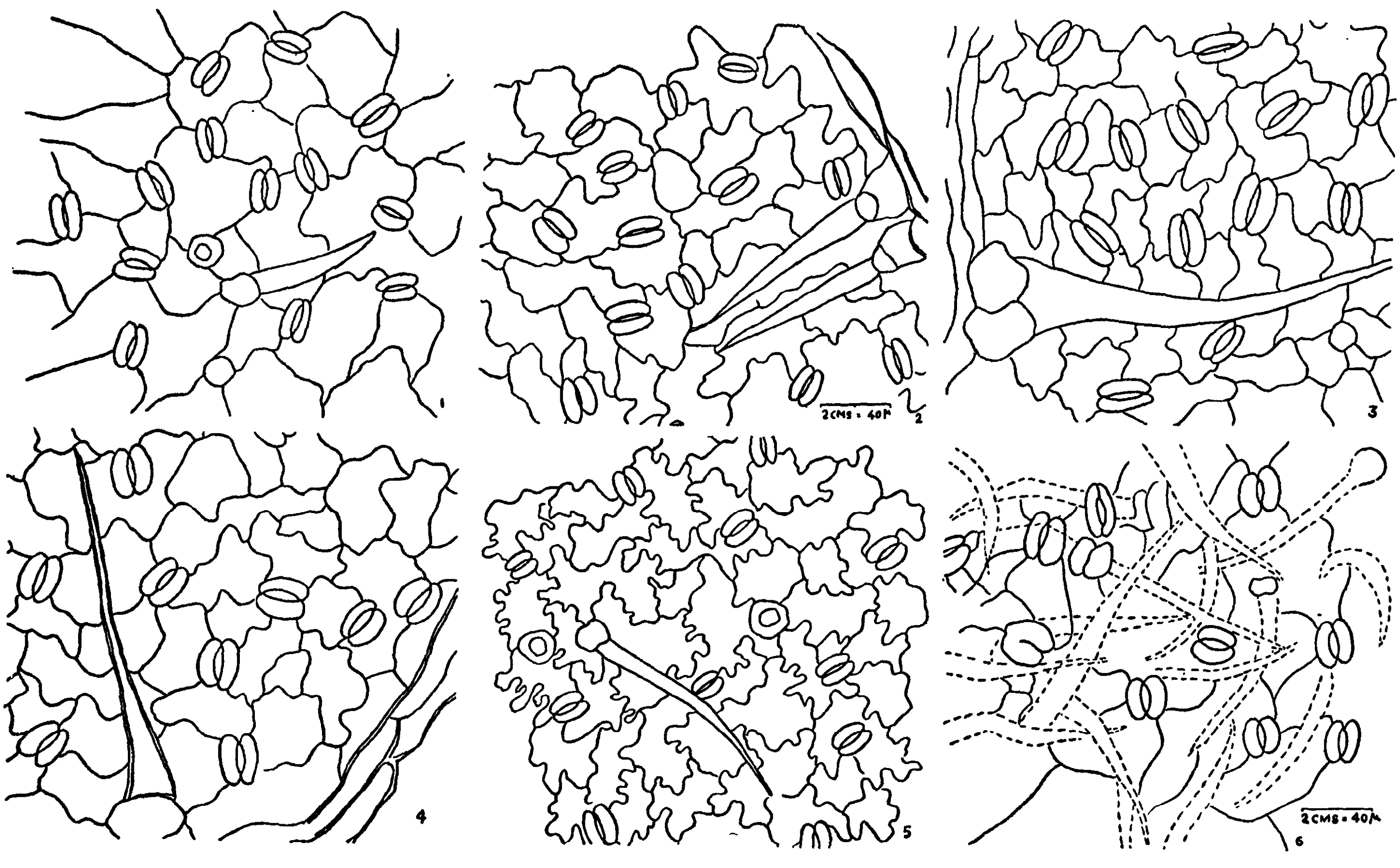

PLATE I. Epidermal patterns in the genus *Lantana*.
Fig. 1. *Lantana camara* var. *nivea* Bailey (2n=22); Fig. 2. *Lantana camara* var. *crocea* Bailey (2n=22); Fig. 3. *Lantana camara* var. *mutabilis* Bailey (2n=33); Fig. 4. *Lantana camara* var. *mutabilis* Bailey (2n=44); Fig. 5. *Lantana montevidensis* Briq. (2n=36); Fig. 6. *Lantana wightiana* Wall. (2n=72).

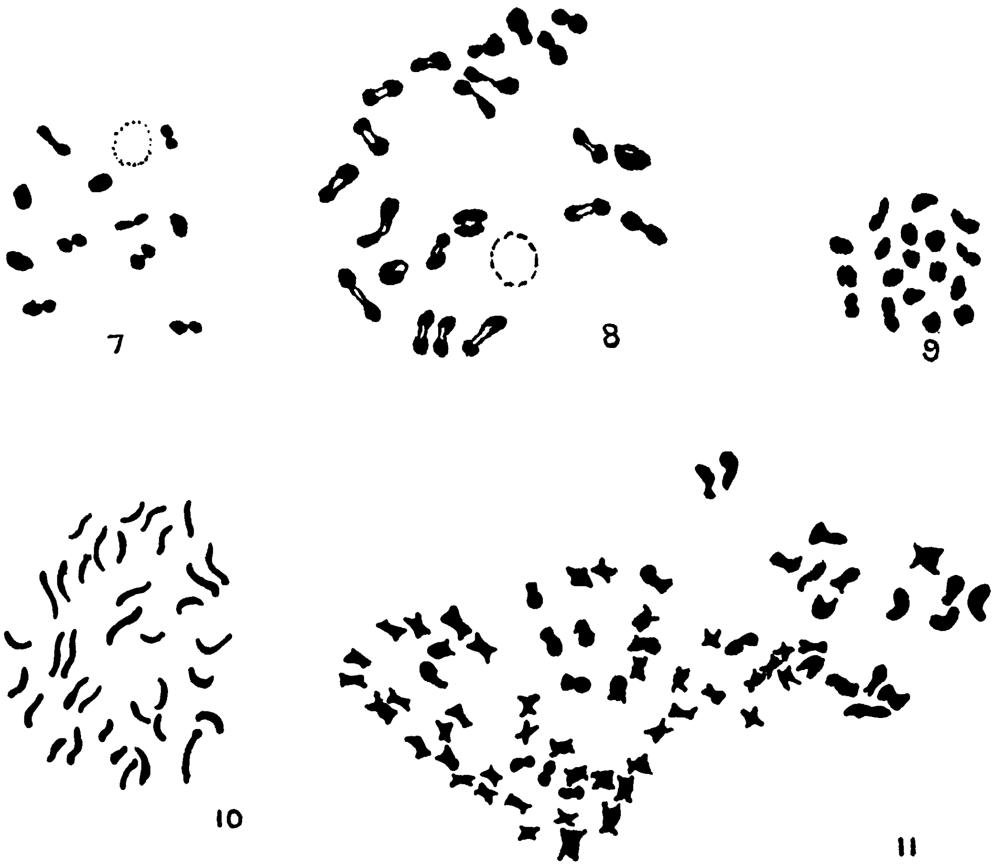

PLATE II

Fig. 7. Metaphase I of *L. camara* var. *nivea* showing n = 11 bivalents × 2400; Fig. 8. Meiosis showing 22 regular bivalent formation in *L. camara* var. *mutabilis* (2n = 44) × 2400; Fig. 9. Metaphase I of *L. montevidensis* showing n = 18 × 2400; Fig. 10. Somatic metaphase of *L. montevidensis* showing 2n = = 36 chromosomes × 2400; Fig. 11. Somatic metaphase of *L. wightiana* showing 2n = 72 chromosomes × 2400.