CYTOLOGY

CYTOLOGY

Observations

For better comparison of the karyotypes a uniform categorization based on length and arm ratios i.e. short arm/long arm (R_1) and long arm/short arm (R_2) of chromosomes is adopted (Adhikary, 1974). This facilitates in understanding the interspecific and intergeneric relationships of the taxa analysed.

Types :

Long chromosomes - length more than 5 μ.

A - with nearly median centromere (nm) (R_1= 0.99-0.61 and R_2= 1.01-1.63).

B - with nearly sub-median centromere (nsm) (R_1= 0.60-0.34 and 0.32-0.23 R_2= 1.64-2.99 and 3.01-4.26).

Medium chromosomes - length 3 μ to less than 5 μ.

C - with median centromere (M) (R_1 and R_2 = 1.0)

D - with nearly median centromere (nm) (R_1= 0.99-0.61 and R_2= 1.01-1.63)

E - with nearly sub-median centromere (nsm) (R_1= 0.60-0.34 and 0.32-0.23 and R_2=1.64-2.99 and 3.01-4.26).

Short chromosomes - length 1 μ to less than 3 μ.

F - with median centromere (M) (R_1 and R_2 = 1.0).

G - with nearly median centromere (nm) (R_1= 0.99-0.61 and R_2= 1.01-1.63)

H - with sub-median centromere (SM) (R_1= 0.33 and R_2= 3.00)

I - with nearly sub-median centromere (nsm) (R_1=0.60-0.34 and 0.32-0.23 and (R_2=1.64-2.99 and 3.01-4.26)

Very short chromosomes - length less than 1 μ .

J - with median centromere (M) (R_1 and R_2 = 1.0).

K - with nearly median centromere (nm) (R_1= 0.99-0.61 and R_2= 1.01-1.63).

L - with nearly sub-median centromere (nsm) (R_1=0.60-0.34 and 0.32-0.23 and R_2=1.64-2.99 and 3.01-4.26).

Superscript :

S - denotes satellites (SATs)

S'- denotes secondary constriction on long arm } (Sec.consts.)

S"- denotes secondary constriction on short arm. }

Tribe - Hibisceae

Genus - Hibiscus Linn.

1. H. sabdariffa Linn.

The cytological study includes 5 varieties (1 wild and 4 cultivated) of the species. The species has been earlier investigated cytologically by a number of workers viz. 2n = 72 Narasingarao (1935); n = 36 Skovsted (1935); 2n = 36, 72 Skovsted (1941); 2n = 72 Tjio (1948); n = 36 Menzel and Wilson (1963) and 2n = 36 Kachecheba (1972).

Chennaveeraiah and Subbarao (1965) have worked out 2 varieties of H. sabdariffa, where they have reported 2n = 72. The n and 2n numbers encountered in the presently investigated taxa are 36 and 72 respectively.

1. a) H. sabdariffa Linn. var. sabdariffa : Coll. No. 7.

$$2n = 72 = F_6 + G_{34} + G_2^S + I_{22} + I_2^S + K_6$$

The somatic metaphase plate showed the following types of chromosomes (Figs. 6, 7 and 16).

i) 3 pairs are with median centromeres represented by F type only.

ii) 21 pairs (G and K - types) are with nearly median centromeres. 1 pair (G^S- type) is having satellites.

iii) 12 pairs (I-type) are with nearly sub-median centromeres. 1 pair (I^S- type) is satellited.

iv) Chromosomes are of short size, ranging in length from 2.25 μ to 0.78 μ with a mean length of 1.54 μ. TF% (39.50), shows more or less symmetrical nature, relative length and idiogram show a graded nature of the karyotype (Fig. 16).

Narasingarao (1935) has not reported any satellited

Hibiscus sabdariffa Linn.

var. sabdariffa (Coll. No. 7) :

Figs. 6 and 7 - Somatic metaphase plate.
(Camera lucida drawing and photo-micrograph).

var. 1-4 Red (Coll. No. 60) :

Figs. 8 and 9 - Somatic metaphase plate.
(Camera lucida drawing and photo-micrograph).

var. 1-9 Red (Coll. No. 61) :

Figs. 10 and 11 - Somatic metaphase plate.
(Camera lucida drawing and photomicrograph).

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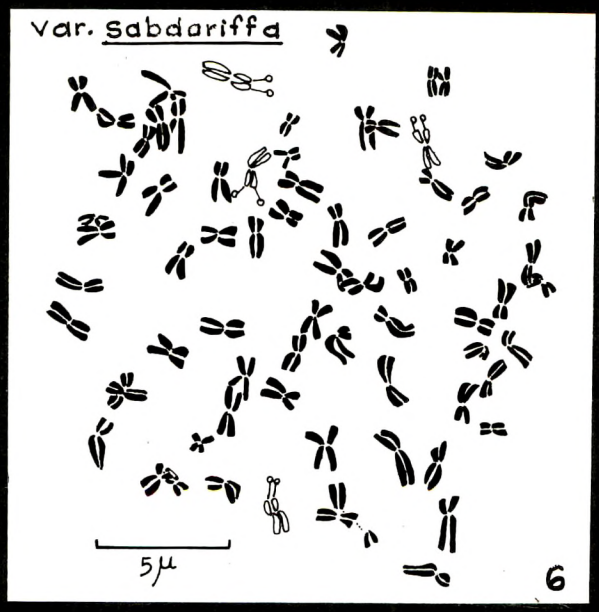
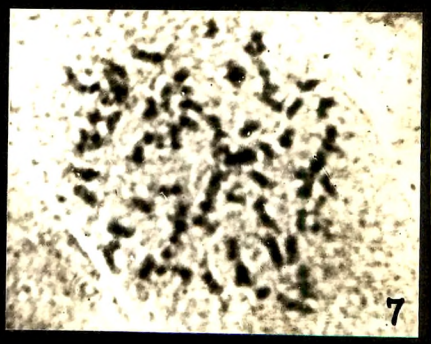

Var. Sabdariffa
5μ
6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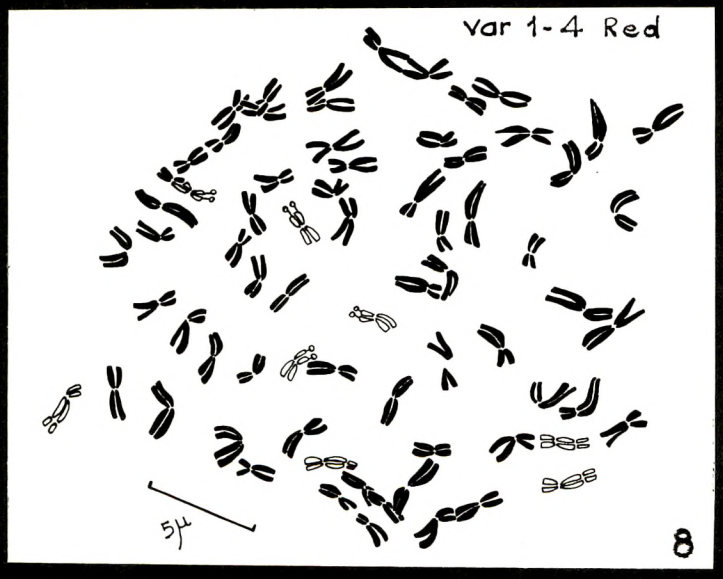
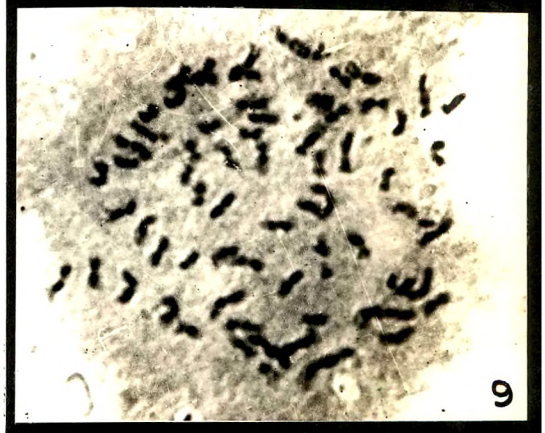

Var 1-4 Red
5μ
8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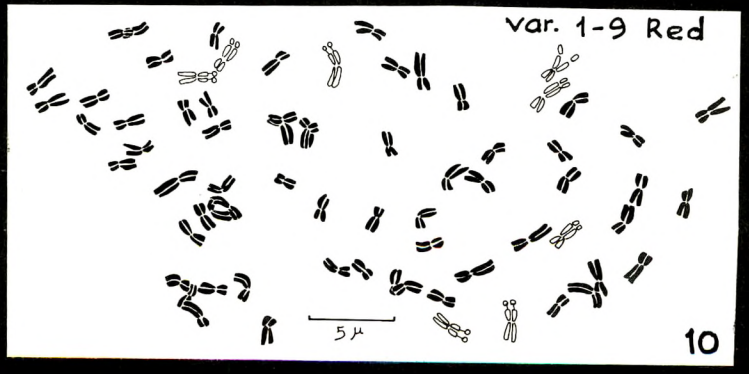
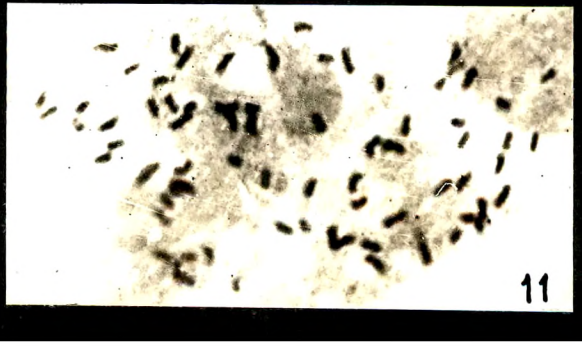

Var. 1-9 Red
5μ
10


11

chromosomes. Skovsted (1941) has reported one pair of satellited chromosomes in a tetraploid taxon, and Kachecheba (1972) has reported 3 pairs of satellited chromosomes in a diploid taxon. The present investigation reveals the presence of 2 pairs of satellited chromosomes in a tetraploid taxon.

1. b) H. sabdariffa Linn. var. 1-4 Red; Coll. No. 60.

$$2n = 72 = G_{48} + G_2^S + I_{16} + I_2^S + I_4^{S'}$$

Somatic complement includes the following types of chromosomes (Figs. 8, 9 and 16).

i) Of the 25 pairs (G-type) with nearly median centromeres 1 pair (G^S-type) is with satellites.

ii) Amongst 11 pairs (I-type) with nearly sub-median centromeres 1 pair (I^S-type) is satellited and two pairs ($I^{S'}$-type) are with secondary constrictions on long arms.

iii) Chromosomes are of short size, range in length from 2.98 μ to 1.28 μ with a mean length of 2.19 μ. The TF% being 39.31 indicates more or less symmetrical nature of the karyotype. Idiogram and relative length reveal a graded nature of the karyotype (Fig. 16).

1. c) H. sabdariffa Linn. variety 1-9 Red; Coll. No. 61.

$$2n = 72 = G_{34} + G_2^S + G_2^{S'} + I_{30} + I_2^S + I_2^{S'}$$

Somatic complement shows the following types of chromosomes (Figs. 10, 11 and 16)

i) 19 pairs (G-type) are with nearly median centromeres. 1 pair (G^S-type) is satellited and another pair ($G^{S'}$-type) is with secondary constrictions on long arms.

ii) 17 pairs (I-type) are with sub-median centromeres, out of which 1 pair (I^S-type) is satellited and another pair ($I^{S'}$-type) is with secondary constriction on long arms.

iii) Chromosomes are short in size, length ranges from 2.47 μ to 1.19 μ with a mean length of 1.71 μ. TF% being 38.23 indicates a slight asymmetrical nature, idiogram and relative length show graded nature of the karyotype (Fig. 16).

1. d) H. sabdariffa Linn. var. 9 Green; Coll. No. 62.

$$2n = 72 = D_4 + F_2 + G_{34} + G_4^S + G_2^{S'} + G_4^{S''} + I_{20} + I_2^S$$

Somatic complement shows the following types of chromosomes (Figs. 12, 13 and 16).

var. 9 Green (Coll. No. 62) :

Figs. 12 and 13 - Somatic metaphase plate (Camera lucida drawing and photomicrograph).

var. 1-1 Green (Coll. No. 63) :

Figs. 14 and 15 - Somatic metaphase plate (Camera lucida drawing and photomicrograph).

Fig. 16 - Idiograms.

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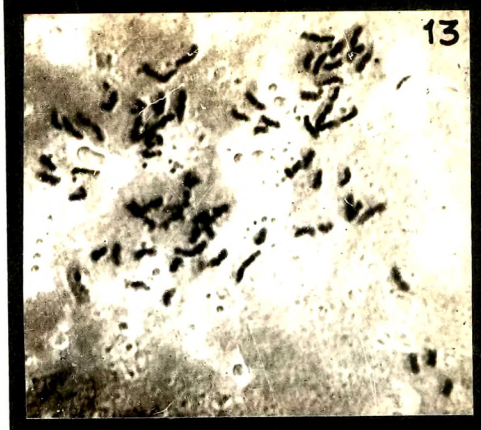
Var. 9 Green
5μ
12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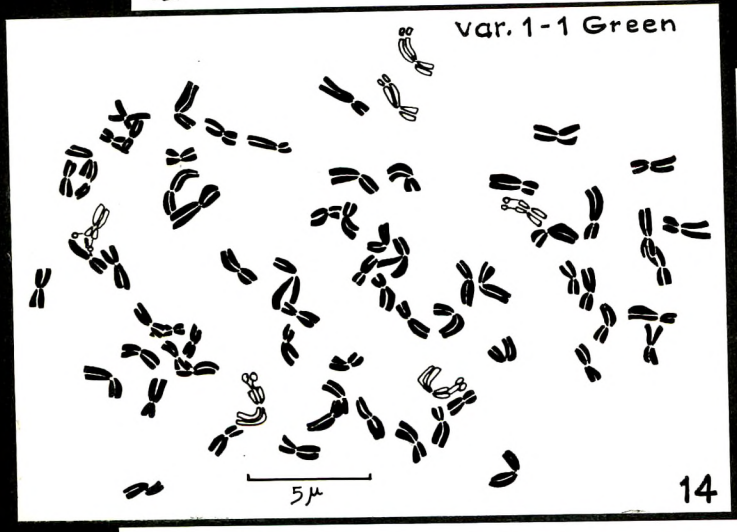
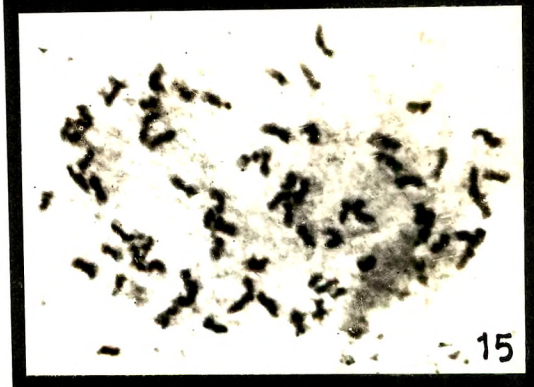

Var. 1-1 Green
5μ
14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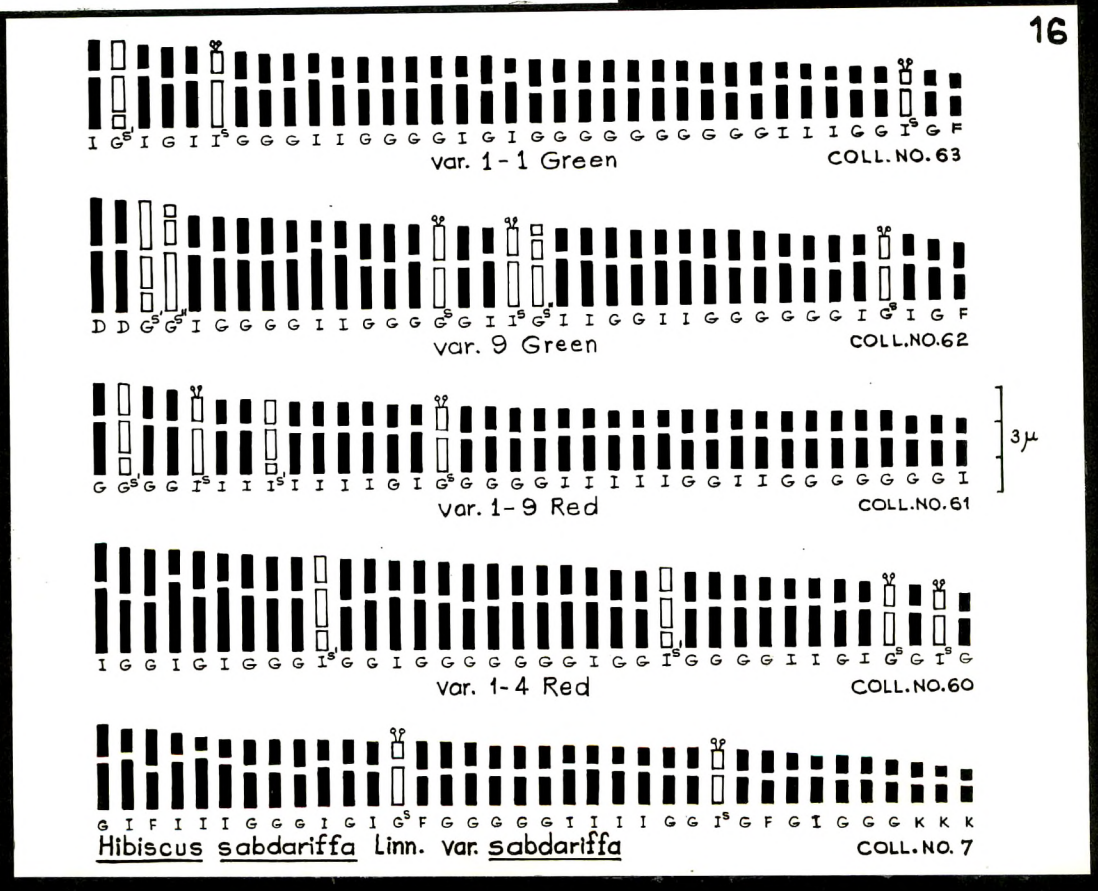

16
I GS I G I IS G G G I I G G G G I G I G G G G G G G G G I I I G G IS G F
var. 1-1 Green
COLL. NO. 63
D D GS GS I G G G G I I G G G GS G I IS GS I I G G I I G G G G G G I GS I G F
var. 9 Green
COLL. NO. 62
G GS G G IS I I I IS I I I I G I GS G G G G I I I I I G G I I G G G G G G I
3μ
var. 1-9 Red
COLL. NO. 61
I G G I G I G G G I S G G I G G G G G G G G I G G IS G G G G I I G I GS G IS G
var. 1-4 Red
COLL. NO. 60
G I F I I I G G G I G I GS F G G G G G G I I I I G G IS G F G I G G G G K K K
Hibiscus sabdariffa Linn. var. sabdariffa
COLL. NO. 7

i) 1 pair (F-type) is with median centromere.

ii) 24 pairs (D and G -types) are with nearly median centromeres. In which 2 pairs (G^{S}-type) of chromosomes with satellites, 1 pair ($G^{S'}$-type) with secondary constriction on long arms and 2 pairs ($G^{S''}$-type) with secondary constriction on short arms are observed.

iii) 11 pairs (I-type) are with nearly sub-median centromeres. Out of which 1 pair (I^{S}-type) is satellited.

iv) Except for 2 pairs of medium size all other chromosomes are short in size. Length ranges from 3.10 μ to 1.45 μ with a mean length of 2.15 μ. TF% being 40.35 shows symmetrical nature, idiogram and relative length reveal a graded nature of the karyotype (Fig. 16).

1. e) H. sabdariffa Linn. var. 1-1 Gree; Coll. No. 63.

$$2n = 72 = F_2 + G_{44} + G_2^{S'} + I_{20} + I_4^{S} .$$

The following types of chromosomes have been observed in the somatic complement (Figs. 14-15 and 16).

i) 1 pair (F-type) is with median centromere.

ii) 23 pairs (G-type) are with nearly median centromeres.

Table II

Comparison of somatic chromosomes of different varieties of H. sabdariffa Linn.

Populations	Somatic number (2 n)	M	nm			nsm	Sec. Consts.		SATs	Range of chromo-some length (in μ)	Absolute length (in μ)
		Type F	Types D	G	K	Type I	Long arm	Short arm			
var. sabdariffa (Coll. No. 7)	72	6	-	36	6	24	-	-	4	2.25-0.78	110.45
var. 1-4 Red. (Coll. No. 60)	72	-	-	50	-	22	4	-	4	2.98-1.28	157.49
var. 1-9 Red. (Coll. No. 61)	72	-	-	38	-	34	4	-	4	2.47-1.19	123.16
var. 9 - Green. (Coll. No. 62)	72	2	4	44	-	22	2	4	6	3.10-1.45	154.19
var. 1-1-Green (Coll. No. 63).	72	2	-	46	-	24	2	-	4	2.30-1.09	119.03

One pair ($G^{S'}$-type) is with secondary constrictions on long arm.

iii) 12 pairs (I-type) are with nearly sub-median centromeres. 2 pairs (I^{S}-type) are having satellites.

iv) The chromosomes are of short size. Range in length from 2.30 μ to 1.09 μ with a mean length of 1.66 μ. TF% being 38.39, relative length and idiogram indicate slight asymmetrical and graded nature of the karyotype (Fig. 16).

Though morphological differences among the varieties are observed in a few characters only(Fig. 1) still they show distinct karyotypic differences. All of them have 2n = 72 chromosomes in their somatic complements. They differ from each other in number of chromosomes in each type, in number of satellited and secondarily constricted chromosomes, and in total chromatin length (Table II).

In all the varieties meiosis is regular showing 36 bivalents at metaphase I (Figs. 17, 18 and 19). This is in confirmation with the earlier works of Skovsted (1935) and Menzel and Wilson (1963). However, some abnormalities like grouping (8 groups) of bivalents (Fig. 20), non-congressional

Meiotic stages

var. sabdariffa (Coll. No. 7)

Fig. 18 - Metaphase I showing 36 bivalents.

var. 1-4 Red (Coll. No. 60)

Fig. 19 - Metaphase I showing 36 bivalents.

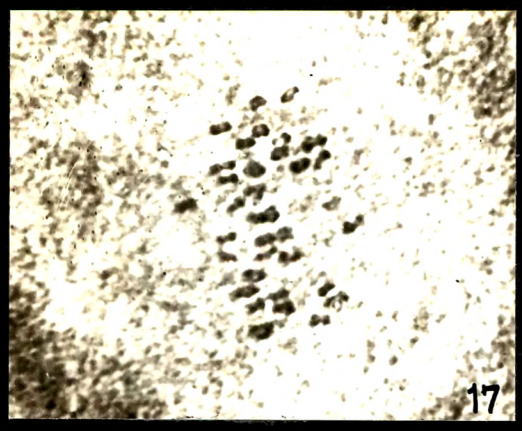
var. 9 Green (Coll. No. 62)

Fig. 17 - Metaphase I showing 36 bivalents.

Fig. 20 - Metaphase I showing 8 groups of bivalents.

Fig. 21 - Metaphase I showing non-congressional bivalents (↑)

Fig. 22 - Anaphase I showing laggard (↑).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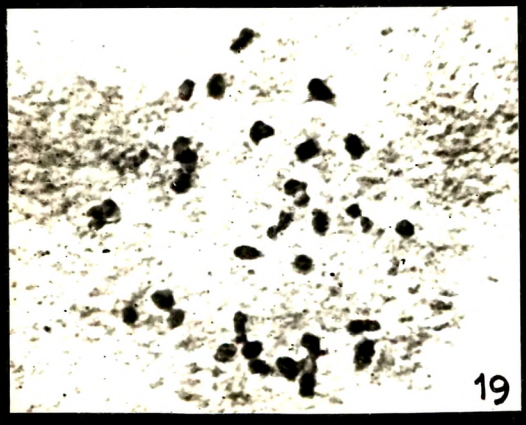
18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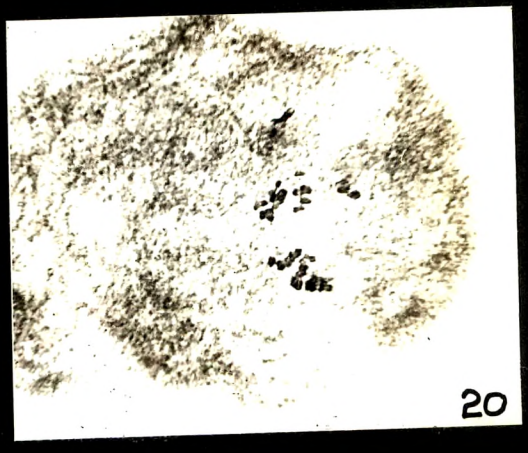
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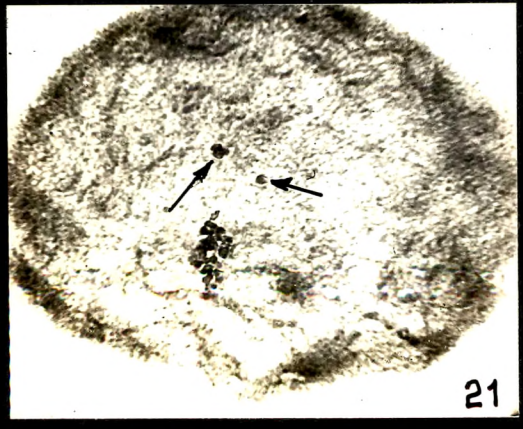
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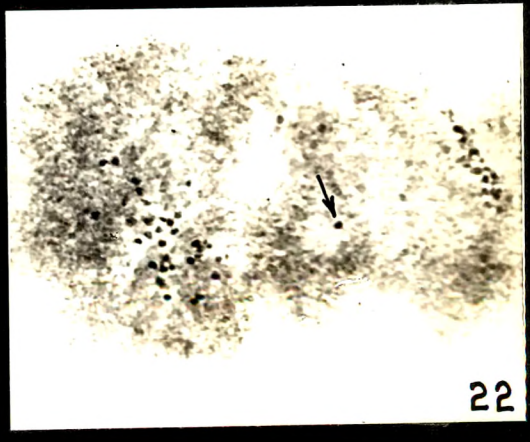
22

bivalents (Fig. 21) at metaphase I and laggards at anaphase I (Fig. 22) in variety 9 Green were noticed. The pollen fertility determined was 95% in wild variety, 90% in 1-4 Red; 91% in 1-9 Red; 89% in 9-Green and 85% in 1-1 Green.

2. H. cannabinus Linn.

4 collections (2, 14, 22 and 24) were cytologically investigated in the present work.

Earlier reports of 2n = 36 by Breslavetz et al. (1934); Medvedeva (1936); Skovsted (1941); Tjio (1948); Chennaveeraiah and Subbarao (1965) are confirmed. However, Narasingarao (1935) and Ford (1938) have reported 2n = 72 for the species.

Coll. Nos. 2, 14 and 22.

$$2n = 36 = D_4 + E_2 + F_8 + G_{10} + G_2^S + G_2^{S'} + I_8$$

The complement includes the following types of chromosomes (Figs. 23, 24 and 25).

i) 4 pairs (F-type) are with median centromeres.

ii) 9 pairs (D and G -types) are with nearly median

H. cannabinus Linn.

Coll. No. 14

Figs. 23 and 24 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 25 - Idiogram.

Fig. 26 - Diakinesis showing 18 bivalents with 2 bivalents attached to the nucleolus

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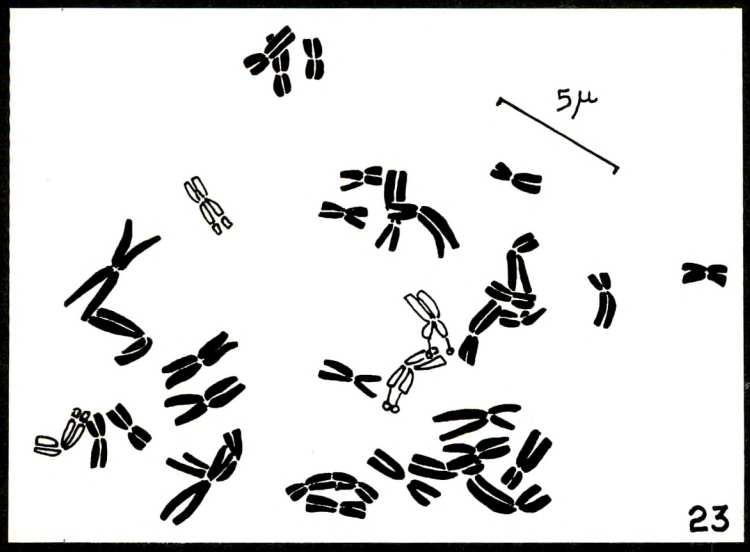
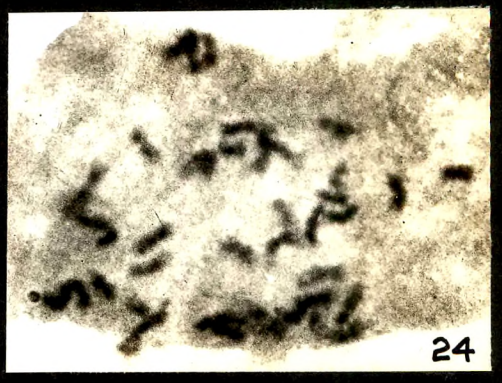

5μ
23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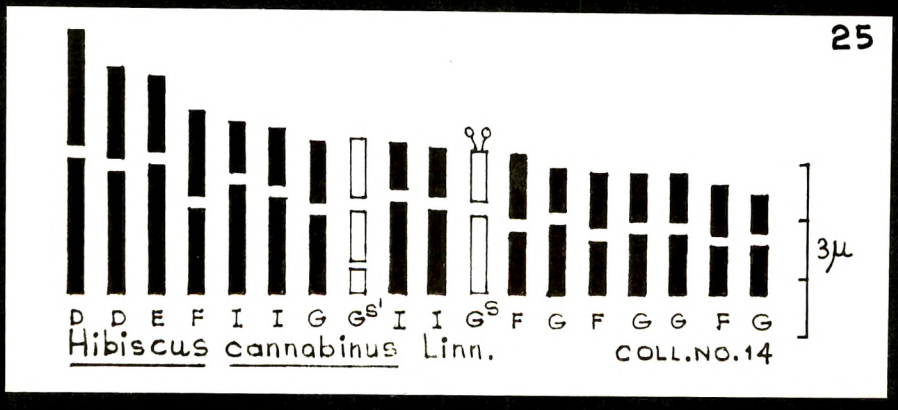
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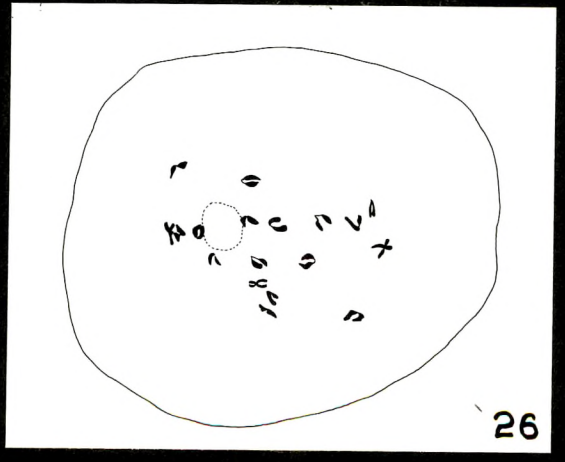
3μ
D D E F I I G Gs' I I Gs F G F G G F G
Hibiscus cannabinus Linn.
COLL.NO.14


26

centromeres, out of which 1 pair (G^S-type) is satellited and 1 pair ($G^{S'}$-type) is with secondary constrictions on long arms.

iii) 5 pairs (E and I -types) are with nearly sub-median centromeres.

iv) Chromosomes are medium to short size , length ranges from 4.20 μ to 1.51 μ with a mean length of 2.48 μ. TF% of 39.77 shows more or less symmetrical nature of the karyotype. Idiogram and relative length reveal an abruptly graded nature of the karyotype (Fig. 25).

Coll. No. 24 :

$$2n = 36 = F_2 + G_{20} + I_8 + I_2^S + I_2^{S'} + K_2.$$

The complement consists of the following types of chromosomes (Figs. 27, 28 and 29).

i) 1 pair (F-type) is with median centromere.

ii) 11 pairs (G and K types) are with nearly median centromeres.

iii) 6 pairs (I-type) are with nearly sub-median centromeres,

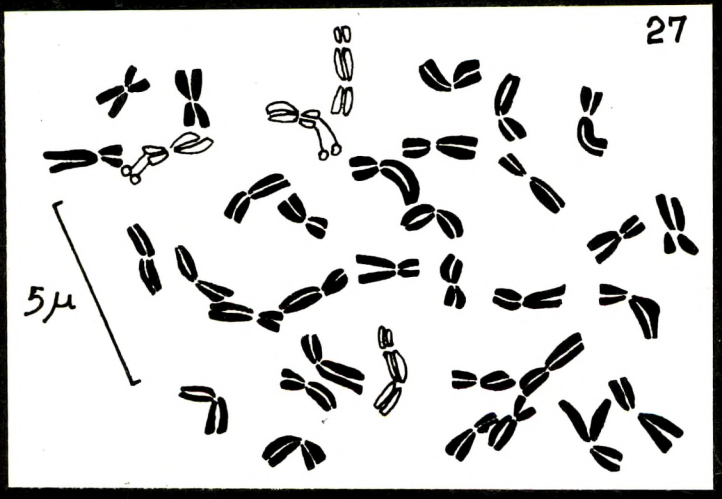
Coll. No. 24 :

Figs. 27 and 28 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 29 - Idiogram.

Fig. 30 - Metaphase I showing 18 bivalents.

27



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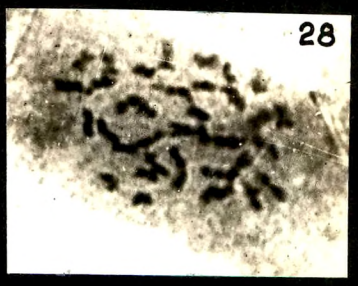

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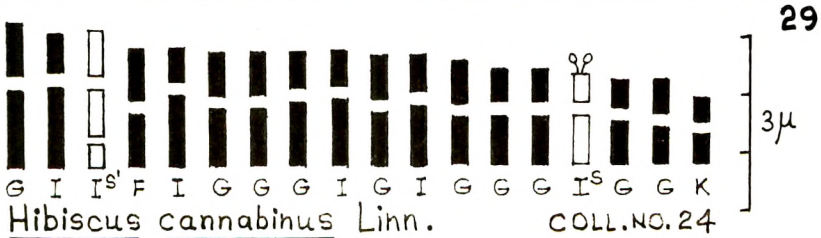


Hibiscus cannabinus Linn. COLL. NO. 24

30

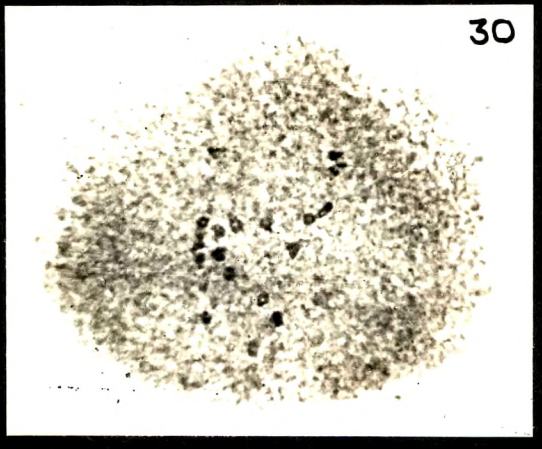


Table III

Comparison of somatic chromosomes of different populations of H. cannabinus Linn.

Populations	Somatic number (2 n)	M	nm			nsm		Sec. Consts. on long arm	SATs	Range of chromo-some length (in μ)	Absolute length (in μ)
		Type	Types			Types					
		F	D	G	K	E	I				
Coll. Nos. 2,14,22	36	8	4	14	-	2	8	2	2	4.20-1.51	89.42
Coll. No. 24	36	2	-	20	2	-	12	2	2	2.30-0.94	60.18

amongst which 1 pair is with satellites (I^S-type) and another pair with secondary constriction on long arms ($I^{S'}$- type).

iv) Chromosomes are medium to short sized, length ranges from 2.30 μ to 0.94 μ with a mean length of 1.68 μ. TF% being 40.25 shows symmetrical nature, idiogram and relative length show a graded nature of the karyotype (Fig. 29).

4 populations collected from different areas resemble among themselves in gross morphology. However, Coll. No. 24 differs from the other collections in the karyotypes as mentioned in the Table III. Therefore, it may be presumed that 2 cytotypes are present within the species.

In the earlier karyomorphological studies of Breslavetz et al. (1934); Narsingarao (1935); Ford (1938), no SAT-chromosomes were observed. Whereas Medvedeva (1936) and Skovsted (1941) have reported 1 pair of SAT-chromosomes in their works. Recently Chennaveeraiah and Subbarao (1965) have reported 3, 4 and 6 pairs of SAT-chromosomes in different strains of the var. purpureus and 4 pairs in the var. vulgaris of H. cannabinus. In contrast to these

observations, the present study reveals the occurrence of 1 pair of SAT-chromosomes and 1 pair of secondarily constricted chromosomes in all populations.

Meiosis is normal, showing 18 bivalents at diakinesis and metaphase I (Figs. 26 and 30). This confirms the reports by Skovsted (1935); Menzel and Wilson (1963). In diakinesis two bivalents near the nucleolus (Fig. 26) reveal the presence of 1 satellited and 1 secondarily constricted chromosomes in the somatic complement. Pollen fertility determined is 80% to 90% in all the collections.

3. H. vitifolius Linn.

3 collections (Coll. Nos. 4, 21 and 33) have been cytologically investigated.

Skovsted (1935, 1941); Hazra and Sharma (1971) have reported 2n = 34 for the species and the same is confirmed in the present study.

Coll. No. 4 :

$$2n = 34 = D_4 + D_2^{S'} + F_2 + G_{16} + G_2^{S''} + I_6 + I_2^{S'}$$

Somatic complement consists of the following types

H. vitifolius Linn.

Coll. No. 4 :

Figs. 31 and 32 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 33 - Idiogram.

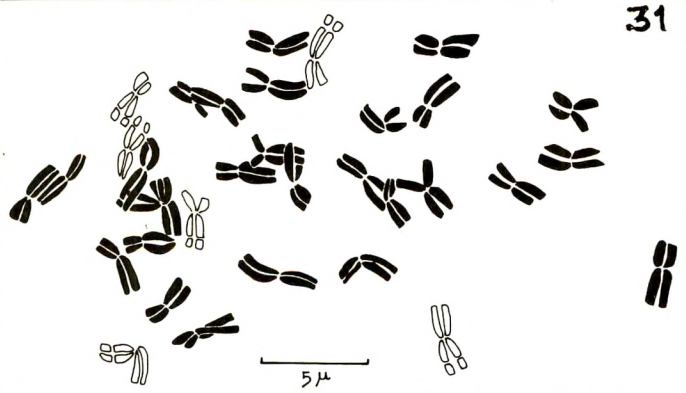
Coll. No. 33 :

Figs. 34 and 35 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 36 - Idiogram.

Contd.....

31



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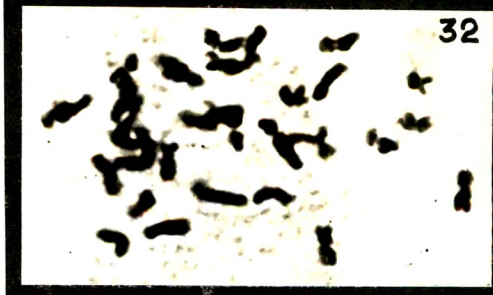

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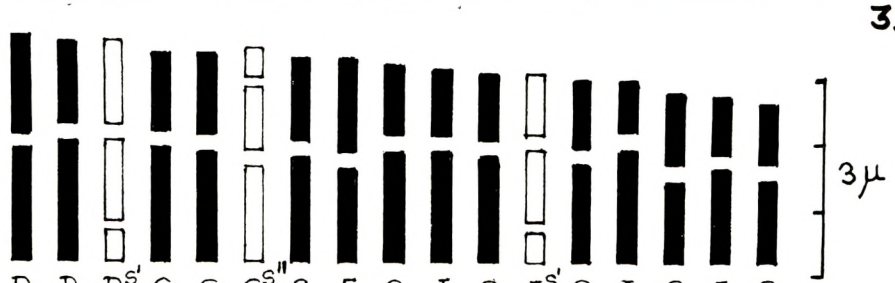
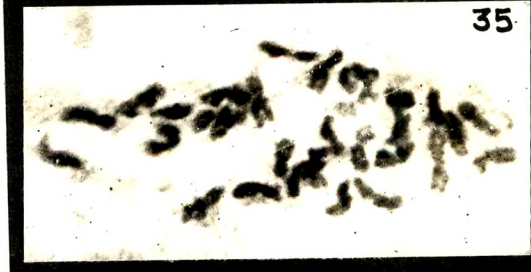


Hibiscus vitifolius Linn COLL.NO. 4

34

35



36

Hibiscus vitifolius Linn. COLL.NO.33

of chromosomes (Figs. 31, 32 and 33).

i) 1 pair (F-type) is with median centromere.

ii) 12 pairs (D and G -types) are with nearly median centromeres, of which 1 pair ($D^{S'}$-type) has secondary constriction on long arm and another pair ($G^{S''}$-type) has secondary constriction on short arms.

iii) 4 pairs (I-type) are with nearly sub-median centromeres, out of which 1 pair ($I^{S'}$-type) has secondary constriction on long arms.

iv) Chromosomes are of medium to short sized, length ranges from 3.23 μ to 2.21 μ with a mean length of 2.76 μ. TF% being 41.64 shows symmetrical nature, idiogram and relative length show a graded nature of the karyotype (Fig. 33).

Coll. Nos. 21 and 33 :

$$2n = 34 \doteq D_{10} + D_6^{S'} + E_2 + E_2^{S''} + G_4 + I_8 + I_2^{S'}$$

The somatic complement shows the following types of chromosomes (Figs. 34, 35 and 36).

Table IV

Comparison of somatic chromosomes of different populations of H. vitifolius Linn.

Populations	Somatic number (2 n)	M	nm		nsm		Sec. Consts.		Range of chromosome length (in μ)	Absolute length (in μ)
		Type	Types		Types					
		F	D	G	E	I	long arm	Short arm		
Coll. No. 4.	34	2	6	18	-	8	4	2	3.23-2.21	93.50
Coll. Nos. 21 and 33.	34	-	16	4	4	10	8	2	4.63-2.31	114.70

i) 10 pairs (D and G -types) are with nearly median centromeres. 3 pairs ($D^{S'}$-type) have secondary constriction on long arms.

ii) 7 pairs (E and I -types) are with nearly sub-median centromeres. 1 pair ($E^{S''}$-type) is with secondary constriction on short arms and another pair ($I^{S'}$-type) is with secondary constriction on long arms.

iii) Chromosomes are medium to short sized, length ranges from 4.63 μ to 2.31 μ with a mean length of 3.37 μ. TF% being 40.78 shows symmetrical nature, idiogram and relative length show more or less graded nature of the karyotype (Fig. 36).

The two karyotypes resemble each other in having same chromosome number as 2n = 34 and 1 pair of chromosomes with secondary constriction on short arms, but they differ from each other in having different numbers of chromosomes in each type and number of chromosomes with secondary constrictions (Table IV).

The similarity in the external morphology of these populations reveals that two cytotypes exist within the species H. vitifolius.

Meiotic stages

Coll. No. 4 :

Fig. 37 - Diakinesis showing 17 bivalents with 3 bivalents attached to the nucleolus.

Fig. 38 - Metaphase I showing 6 groups of bivalents ($1_{(6)} + 2_{(3)} + 2_{(2)} + 1_{(1)}$)

Fig. 40 - Anaphase I showing irregular distribution of chromosomes.

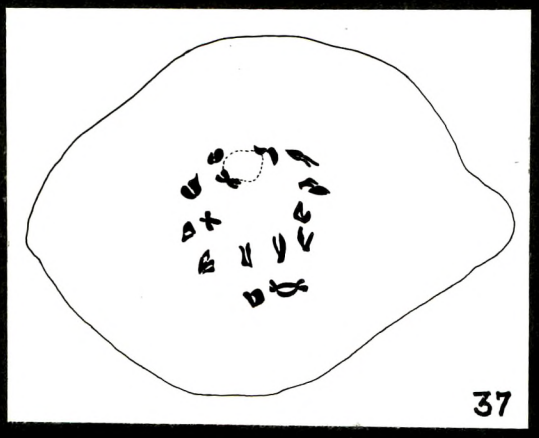
Fig. 41 - Anaphase I showing laggard (↑).

Fig. 42 - Telophase I showing laggard (↑).

Fig. 43 - Pollen tetrads.

Coll. No. 33 :

Fig. 39 - Metaphase I (Side view) showing 17 bivalents.



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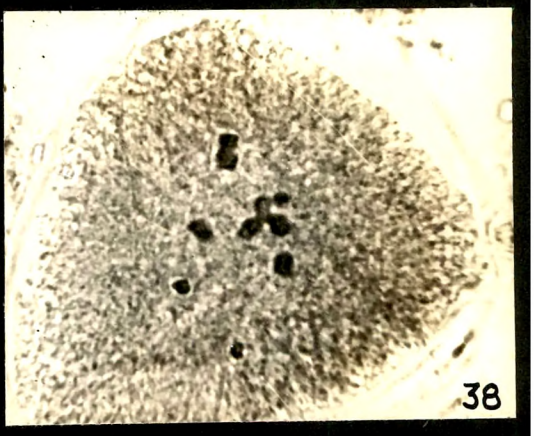

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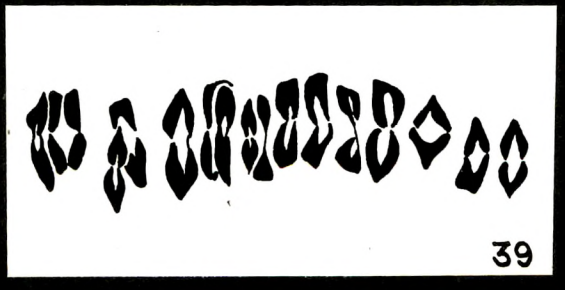

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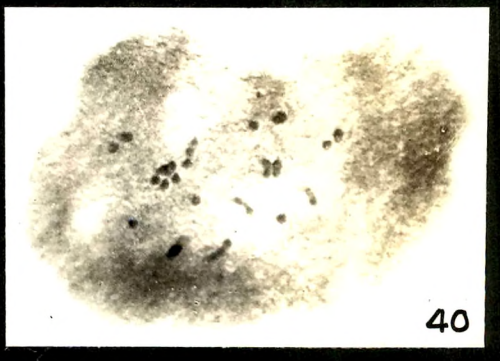

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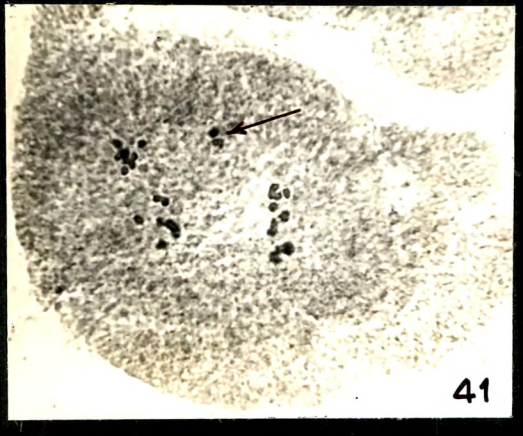

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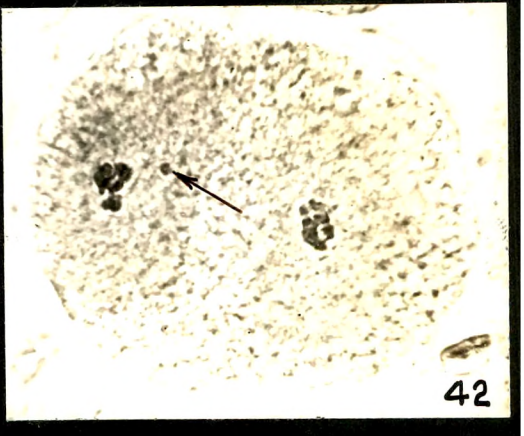

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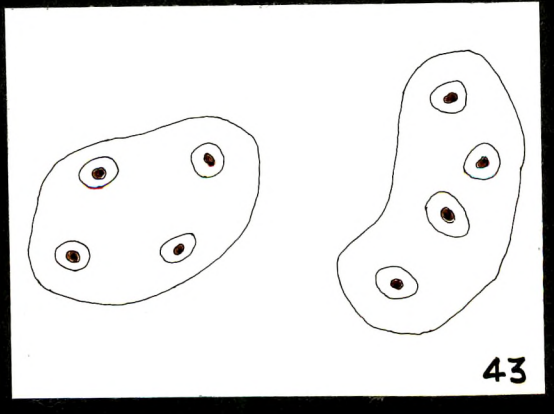


43

A pair of satellited and β-chromosomes reported by Skovsted (1935, 1941) have not been observed in the present work as well as in the work of Hazra and Sharma (1971). Moreover, the presence of 1 pair of chromosomes with secondary constriction on short arms in all collections analysed in the present investigation has not been reported in any of the previous works.

As far could be ascertained from the available literature, this is the first report of meiotic study of the species. The meiotic behaviour of chromosomes is found to be regular in a majority of PMCs showing 17 distinct bivalents at diakinesis and metaphase I (Figs. 37 and 39). However, a few abnormalities like secondary association of bivalents at metaphase I (Fig. 38), irregular distribution of chromosomes at anaphase I (Fig. 40) and laggards or laggard at anaphase I and telophase I respectively (Figs. 41 and 42) were noticed. Tetrads of linear as well as isobilateral types (Fig. 43) have been recorded. All the above mentioned abnormalities are observed in Coll. No. 4 only. The pollen fertility determined was 86.15% for collection No. 4 and 91.55% in Collection Nos. 21 and 33.

4. H. mutabilis Linn.

Earlier reports are 2n = 100 by Medvedeva (1936);

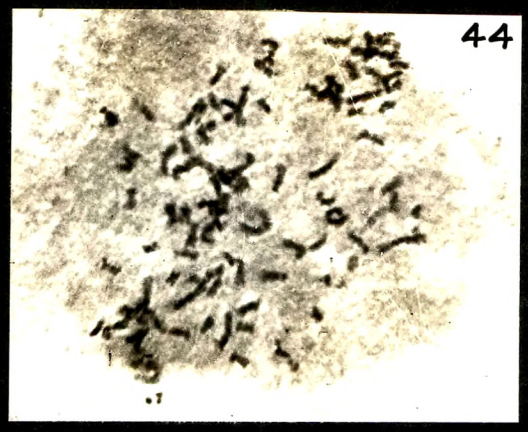
H. mutabilis Linn.

Coll. No. 44 :

Figs. 44 and 45 - Somatic metaphase plate (Photomicrograph and camera lucida drawing).

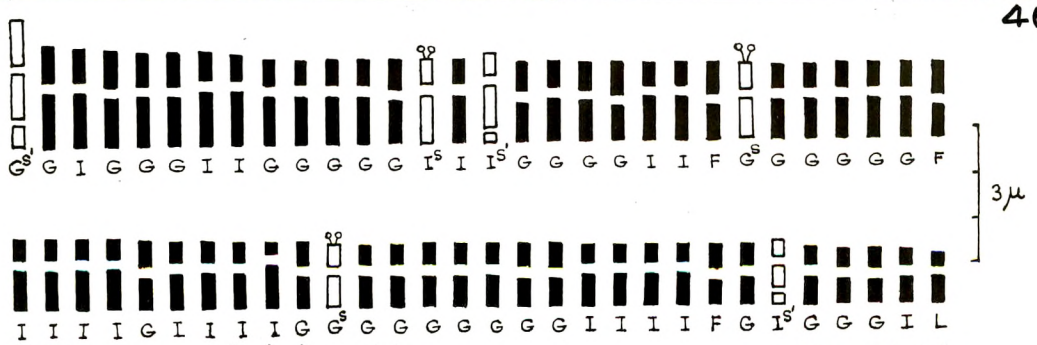
Fig. 46 - Idiogram.

44



45

46



Hibiscus mutabilis Linn. COLL. NO. 44

2n = 92 by Skovsted (1941) and Kuwada (1961); 2n = 84 and 110 by Sharma and Sharma (1962); 2n = 92 and 96 by Kachecheba (1972) for the species. However, the present study showed 2n = 120.

$$2n = 120 = F_6 + G_{62} + G_4^S + G_2^{S'} + I_{38} + I_2^S + I_4^{S'} + L_2$$

The following types of chromosomes are present in the complement (Figs. 44, 45 and 46).

i) 3 pairs (F-type) are with median centromeres.

ii) 34 pairs (G-type) are with nearly median centromeres of which 2 pairs (G^S-type) have satellites and 1 pair ($G^{S'}$-type) has secondary constriction on long arms.

iii) Of the 23 pairs (I and L -types) with nearly sub-median centromeres, 1 pair is satellited (I^S-type) and 2 pairs ($I^{S'}$-type) are secondarily constricted.

iv) Chromosomes are short to very short sized, range in length from 2.55 μ to 0.94 μ with a mean length of 1.51 μ. TF% of 39.22 shows more or less symmetrical nature of the karyotype. Idiogram and relative length show a graded nature of the karyotype (Fig. 46).

In the work of Sharma and Sharma (1962) satellited

and secondarily constricted chromosomes are represented by 6 and 7 pairs in the complements of 84 and 110 chromosomes respectively. However, 6 pairs of chromosomes with satellites and secondary constrictions are observed in the complement of 120 chromosomes in the taxon analysed at present.

5. H. trionum Linn.

The present observation of n = 28 and 2n = 56 is in line with the earlier works of Davie (1933, syn. H. africanus-majus); Skovsted (1935) and Majovsky, et al. (1970). However, 2n = 28 has been reported by Medvedeva (1936), Nakajima (1936); Rao (1941) and Kachecheba (1972) for the species.

$$2n = 56 = D_2 + G_{32} + G_4^S + G_2^{S'} + I_{16}$$

The complement is seen to consist of the following types of chromosomes (Figs. 47, 48 and 49).

i) 20 pairs (D and G -types) are with nearly median centromeres. Of these, 2 pairs of chromosomes (G^S-type) have satellites and 1 pair ($G^{S'}$-type) has secondary constriction on long arm.

H. trionum Linn.

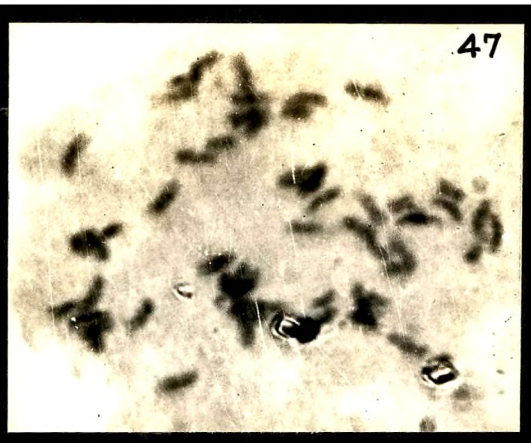
Coll. No. 47 :

Figs. 47 and 48 - Somatic metaphase plate (Photomicrograph and camera lucida drawing).

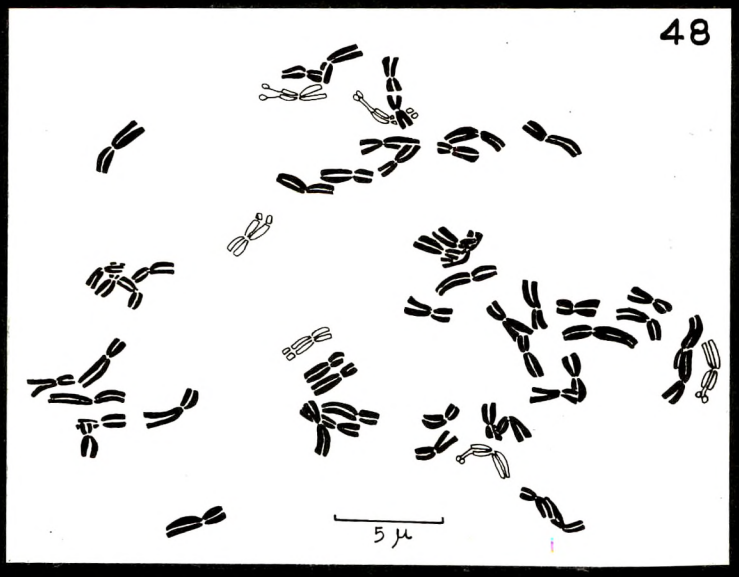
Fig. 49 - Idiogram.

Fig. 50 - Meiotic metaphase I (Polar view) showing 28 bivalents.

47



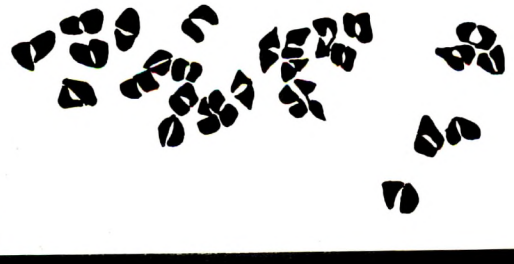
48



49

Hibiscus trionum Linn. COLL.NO.47

50



ii) 8 pairs (I-type) are with nearly sub-median centromeres.

Chromosomes are medium to short sized, ranging in length from 3.32 μ to 1.53 μ with a mean length of 2.22 μ. The relative length and idiogram show the graded nature of the karyotype (Fig. 49). The TF% is 39.29, indicating more or less symmetrical nature of the complement.

Rao (1941) reported 3 pairs of chromosomes with satellites (Trabants) in the taxon analysed by him. In the present study, 2 pairs of SAT-chromosomes and 1 pair of secondarily constricted chromosomes in the somatic complement are observed.

Meiotic study shows the presence of 28 bivalents at metaphase I (Fig. 50). The present observation of n = 28 confirms the earlier observation of Skovsted (1935), but differs from Rao's (1941) report of n = 14. The pollen fertility determined as 85%.

6. H. lobatus (Murr.) O. Kuntze

5 collections (Coll. Nos. 5, 15, 17, 25 and 46) were cytologically examined. The study of these populations

H. lobatus (Murr.) O. Kuntze

Coll. No. 5 :

Fig. 51 - Somatic metaphase plate.

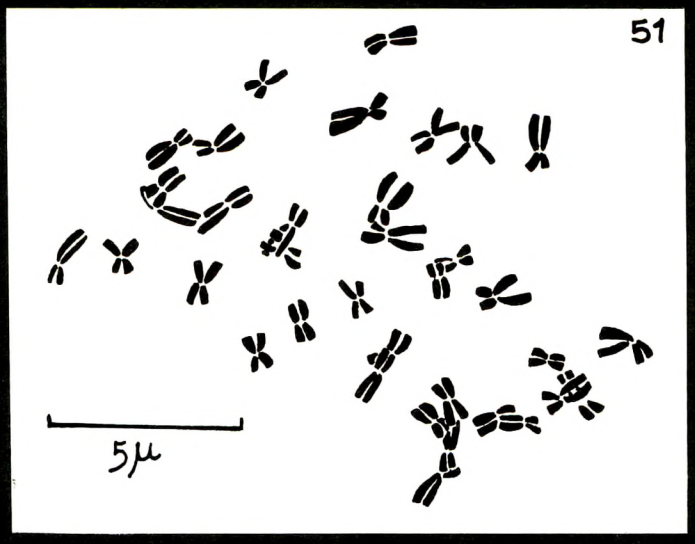
Fig. 52 - Idiogram.

Coll. No. 25 :

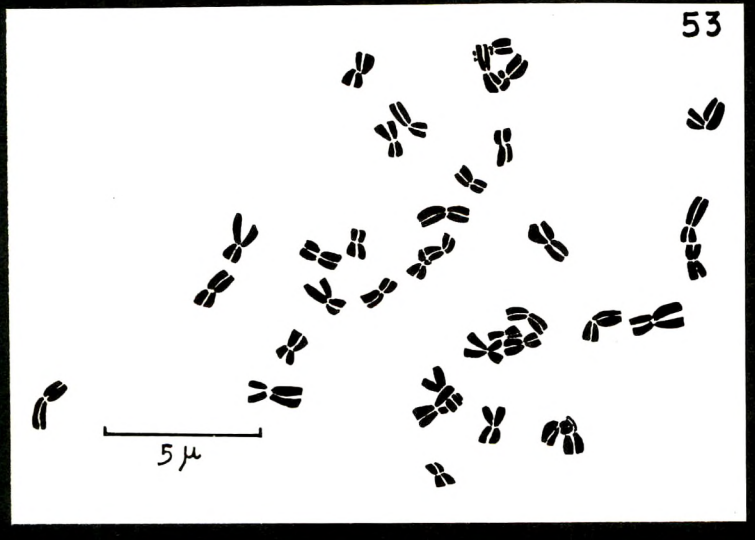
Figs. 53 and 54 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

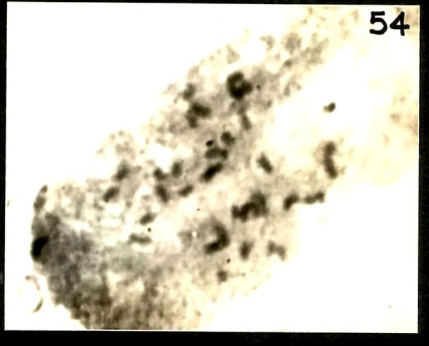
Fig. 55 - Idiogram.

Contd.....


51
5μ


52
3μ
I I G I I I I G G I I G G F K K L K
H. lobatus (Murr.) O. Kuntze COLL. NO. 5


53
5μ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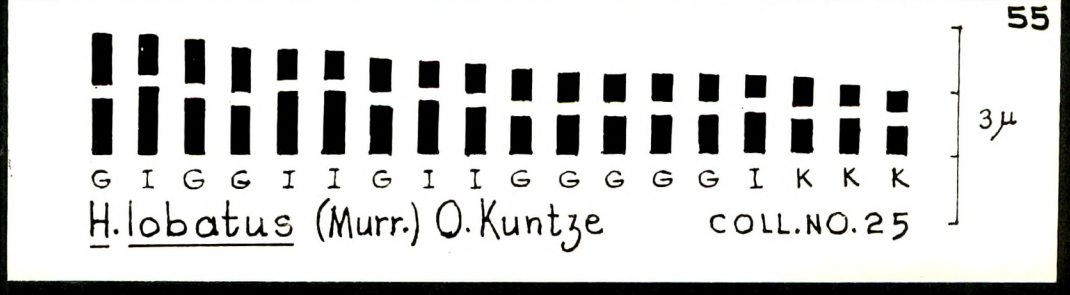

55
3μ
G I G G I I G I I G G G G G I K K K
H. lobatus (Murr.) O. Kuntze COLL. NO. 25

revealed that the 4 populations (Coll. Nos. 5, 17, 25 and 46) are diploid (2n = 36) while the Coll. No. 15 is a tetraploid one (2n = 72). Coll. Nos. 25 and 46 resemble each other in their karyomorphology but differ from Coll. Nos. 5 and 17.

In contrast to earlier reports of 2n = 34 and 68 by Skovsted (1935) and 2n = 34 by Medvedeva (1936), the present reports are 2n = 36 and 72 and n = 18 and 36.

Coll. Nos. 5 and 17.

$2n = 36 = F_2 + G_{10} + I_{16} + K_6 + L_2$.

The somatic complement shows the following types of chromosomes (Figs. 51 and 52).

i) 1 pair (F-type) is with median centromere.

ii) 8 pairs (G and K -types) are with nearly median centromeres.

iii) 9 pairs (I and L -types) are with nearly sub-median centromeres.

iv) Chromosomes are short to very short sized, length ranges from 1.70 μ to 0.85 μ with a mean length of

1.23 μ. TF% being 37.64 indicates asymmetrical nature, idiogram and relative length show a graded nature of the karyotype (Fig. 52).

Coll. Nos. 25 and 46.

$2n = 36 = G_{18} + I_{12} + K_6$.

The complement contains the following types of chromosomes (Figs. 53, 54 and 55).

i) 12 pairs (G and K-types) are with nearly median centromeres.

ii) 6 pairs (I-type) are with nearly sub-median centromeres.

iii) Chromosomes are short to very short sized, length ranges from 1.62 μ to 0.77 μ with a mean length of 1.20 μ. TF% being 40.08 shows symmetrical nature, idiogram and relative length show a graded nature of the karyotype (Fig. 55).

Coll. No. 15.

$2n = 72 = F_4 + G_{26} + H_2 + I_6 + J_6 + K_{24} + L_4$.

The somatic chromosomes can be grouped into the following distinguishable types (Figs. 56, 57 and 58).

Coll. No. 15 :

Figs. 56 and 57 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 58 - Idiogram.

Meiotic stages

Coll. No. 5 :

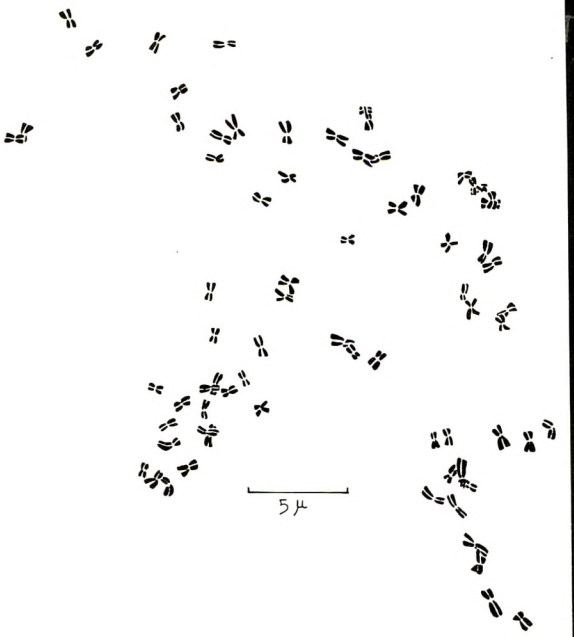
Figs. 59 and 60 - Metaphase I (side view) showing 18 bivalents. (camera lucida drawing and photomicrograph).

Coll. No. 15 :

Fig. 61 - Metaphase I (Polar view) showing 36 bivalents.

Fig. 62 - Metaphase II.

56



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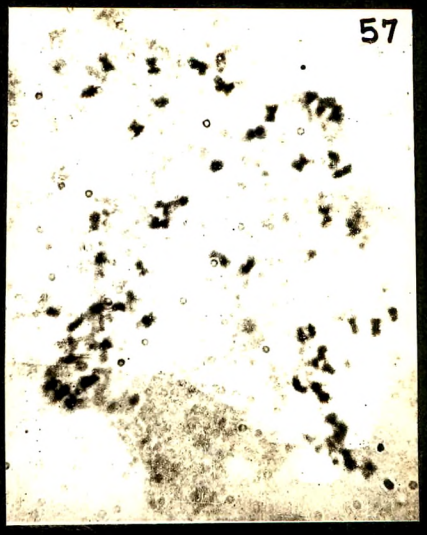


58

H G I G G G I I G G G G G F F G G G G G G K K K K K K K K K J J K K K K L L J

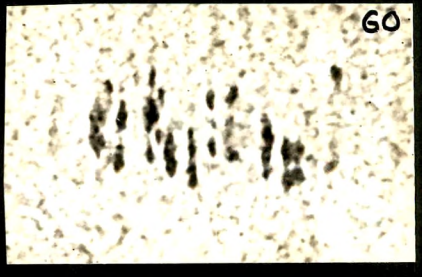
3μ

Hibiscus lobatus (Murr.) O. Kuntze

COLL. NO. 15

59

60



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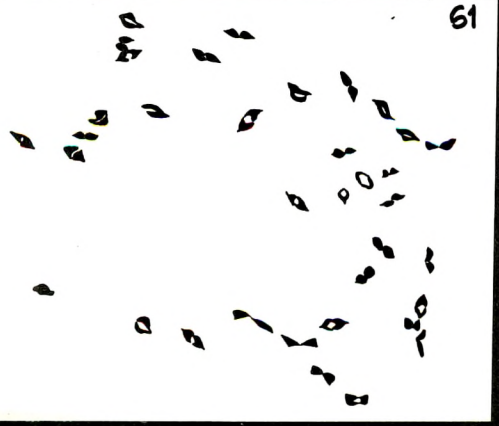


62

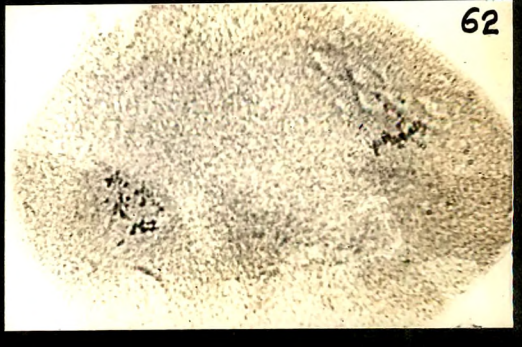


Table V

Comparison of somatic chromosomes of different populations of H. lobatus (Murr.) O. Kuntze

Populations	Somatic number (2 n)	M Types		nm Types		SM Type	nsm Types		Range of chromosome length (in μ)	Ratio of longest to the shortest pair	Absolute length (in μ)
		F	J	G	K	H	I	L			
Coll. Nos. 5 and 17	36	2	-	10	6	-	16	2	1.70-0.85	2.00	44.17
Coll. Nos. 25 and 46	36	-	-	18	6	-	12	-	1.62-0.77	2.11	42.84
Coll. No. 15	72	4	6	26	24	2	6	4	1.36-0.68	2.00	72.15

i) 5 pairs (F and J -types) are with median centromeres.

ii) 25 pairs (G and K -types) are with nearly median centromeres.

iii) 1 pair (H-type) is with sub-median centromere.

iv) 5 pairs (I and L-types) are with nearly sub-median centromeres.

v) Chromosomes are short to very short sized, length ranges from 1.36 μ to 0.68 μ with a mean length of 1.01 μ. TF% being 42.22 shows symmetrical nature, idiogram and relative length show a graded nature of the karyotype (Fig. 58).

All these karyotypes differ from each other in the chromosome types and the number of each type within the complement (Table V).

Three morphologically distinguishable forms represented by Coll. Nos. 15, 5 and 17, 25 and 46 were recognized by polygraphic study (Fig. 2). All these populations showed karyomorphological similarities as well as differences substantiating the groupings made in polygraphic study. Thus, it can be concluded that there

exist 3 distinct ecotypes which are morphologically as well as cytologically different.

Meiosis is regular in all the collections. The presence of 18 and 36 bivalents at diakinesis and metaphase I (Figs. 59, 60 and 61) contradicts the earlier reports of n = 17 by Skovsted (1935). Pollen fertility determined as 80% to 85% in all the collections shows a regular pollen grain formation.

7. Hibiscus hirtus Linn.

Sharma and Sharma (1962) have reported 2n = 70 as the chromosome number in the somatic complement. In the present investigation (Coll. No. 54) n = 32 and 2n = 64 have been observed for the species.

$$2n = 64 = G_{36} + G_2^{S'} + I_{24} + I_2^{S}$$

The somatic complement consists of the following types of chromosomes (Figs. 63, 64 and 65).

i) Of the 19 pairs (G-type) with nearly median centromeres, 1 pair ($G^{S'}$-type) is with secondary constrictions on long arms.

H. hirtus Linn.

Coll. No. 54 :

Figs. 63 and 64 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

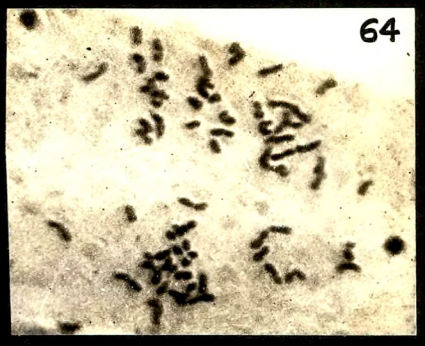
Fig. 65 - Idiogram.

Figs. 66 and 67 - Diakinesis showing 32 bivalents and a nucleolus (photomicrograph and camera lucida drawing).

Fig. 68 - Metaphase I.

63

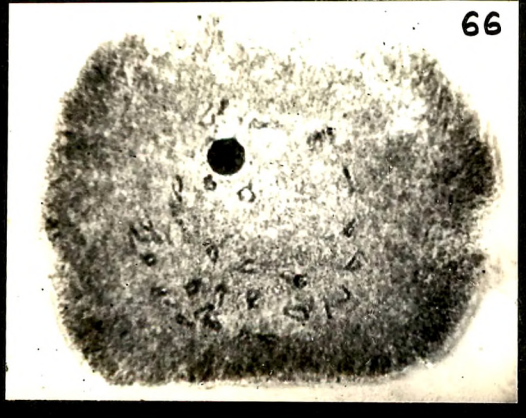
64



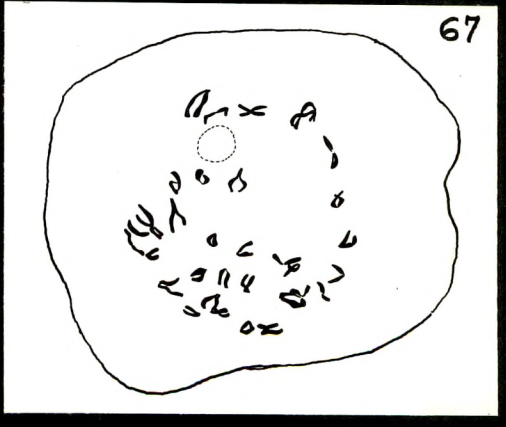
65

Hibiscus hirtus Linn. var. hirtus COLL.NO.54

66



67



68

ii) Chromosomes with nearly sub-median centromeres (I-type) are represented by 13 pairs. Of which 1 pair (I^S-type) is satellited.

iii) Chromosomes are short sized, length ranges from 2.38 μ to 1.02 μ with a mean length of 1.55 μ. TF% is 38.25 indicating asymmetrical nature of the karyotype. Idiogram and relative length show that the first two pairs (I and G -types) are little longer than the other chromosomes in the complement. Except for these two pairs, the karyotype is of graded type (Fig. 65).

Karyomorphological studies of Sharma and Sharma (1962) revealed the presence of 3 pairs of secondarily constricted and 2 pairs of satellited chromosomes in the taxon they have analysed. In contrast to this, only 1 pair of satellited and 1 pair of secondarily constricted chromosomes were noticed in the present study.

No report of meiotic study is available in the literature. Meiosis is normal, showing 32 bivalents at diakinesis and metaphase I. (Figs. 66, 67 and 68). Pollen fertility determined as 85%.

8. Hibiscus ovalifolius (Forsk.) Vahl

Both the collections (Nos. 28 and 56) resemble cytologically in the number and types of chromosomes. Earlier workers like Skovsted (1941); Gill and Abubakar (1975) have reported 2n = 64 and n = 32 respectively for the species. In contrast to these, both collections examined presently show n = 16 and 2n = 32. This is the first report of detailed karyomorphological study for the species.

$2n = 32 = E_2 + G_{24} + I_6$.

The somatic complement has following types of chromosomes (Figs. 69, 70 and 71).

i) 12 pairs (G-type) are with nearly median centromeres.

ii) 4 pairs (E and I -types) are with nearly sub-median centromeres.

iii) Chromosomes are medium to short sized, range in length from 3.06 μ to 1.45 μ with a mean length of 2.17 μ. TF% being 38.97 shows a tendency towards asymmetry. Idiogram and relative length show a graded nature of the karyotype.

H. ovalifolius (Forsk.) Vahl

Coll. No. 56 :

Figs. 69 and 70 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 71 - Idiogram.

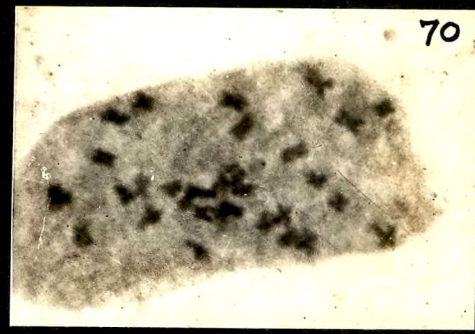
Fig. 72 - Diakinesis showing 16 bivalents.

Fig. 73 - Metaphase I showing non-congressional bivalent (↑).

Contd.....

69

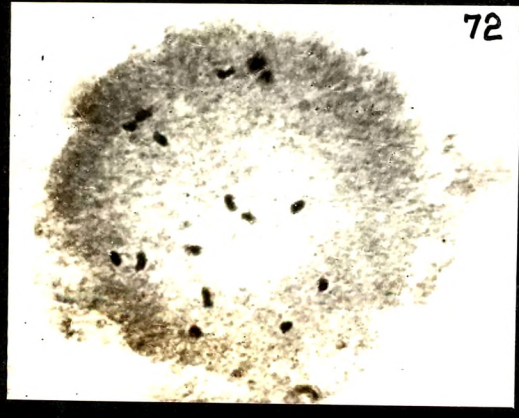
70



71

H. ovalifolius (Forsk.) Vahl COLL. NO. 56

72



73

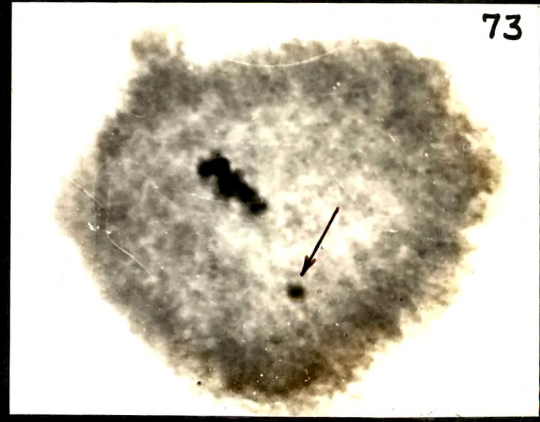


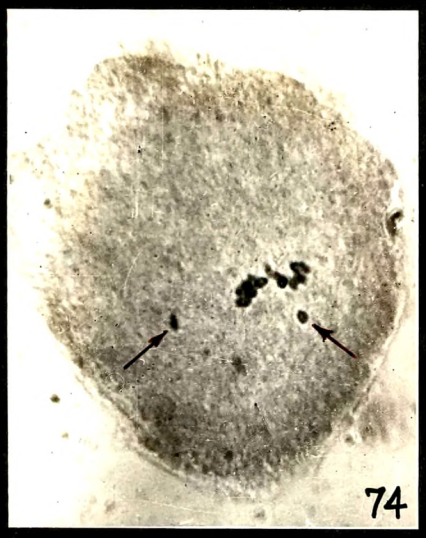
Fig. 74 - Metaphase I showing non-congressional bivalents (↑).

Fig. 75 - Metaphase I showing 5 groups of bivalents.

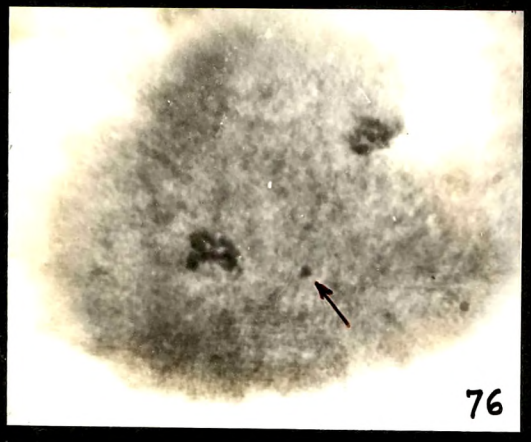
Fig. 76 - Telophase I showing laggard (↑).

Fig. 77 - Anaphase I showing irregular distribution.

Fig. 78 - Anaphase II showing 3 laggards (↑).


74


75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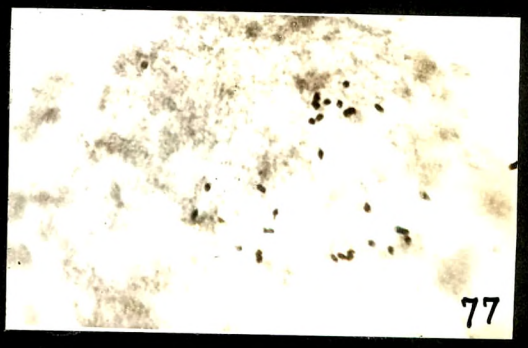

77


78

Meiosis is fairly regular showing 16 bivalents at diakinesis (Fig. 72). However, non-congressional bivalents (Figs. 73 and 74), grouping (5 groups) of bivalents (Fig. 75), irregular distribution (Fig. 77), laggard at telophase I (Fig. 76), and laggards at anaphase II (Fig. 78) were noticed in few PMCs. Pollen fertility is determined as 80%.

9. H. panduraeformis Burm. .

4 populations (Coll. Nos. 3, 9, 26 and 37) were scrutinized for cytological studies. But, for Skovsted's (1941) report of 2n = 24, no other report for the species is available. Present work, confirms the above mentioned report.

Coll. Nos. 3 and 9 :

$$2n = 24 = D_2 + D_2^{S'} + E_2 + F_4 + G_{10} + I_4$$

The complement is seen to consist of the following types of chromosomes (Figs. 79, 80 and 81).

i) 2 pairs (F-type) are with median centromeres.

ii) 7 pairs (D and G -types) are with nearly median centromeres, of which 1 pair ($D^{S'}$-type) contains secondary constriction on long arms.

H. panduraeformis Burm.

Coll. No. 3 :

Figs. 79 and 80 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 81 - Idiogram.

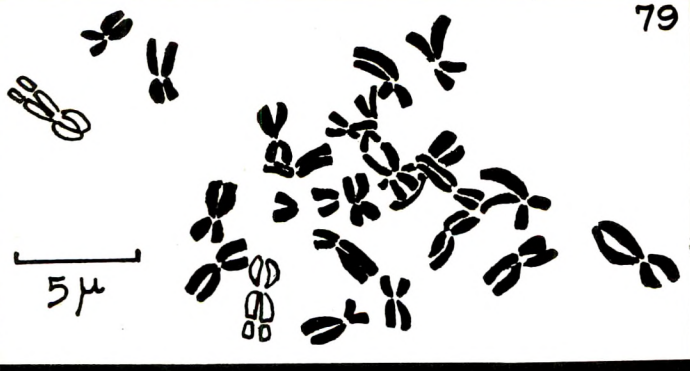
Coll. No. 26 :

Figs. 82 and 83 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

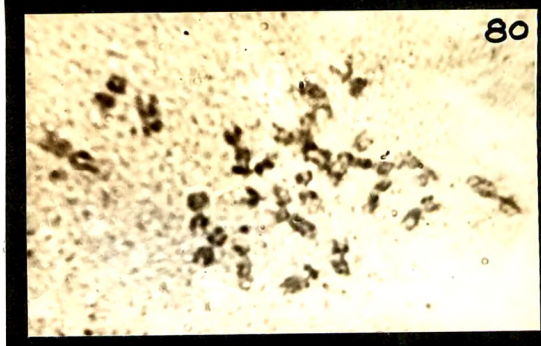
Fig. 84 - Idiogram.

Contd.....

79



80



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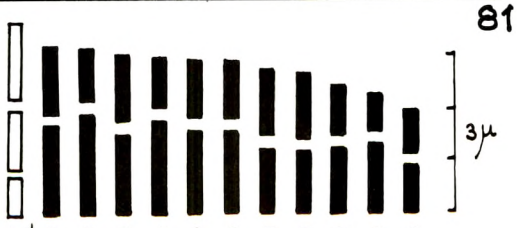
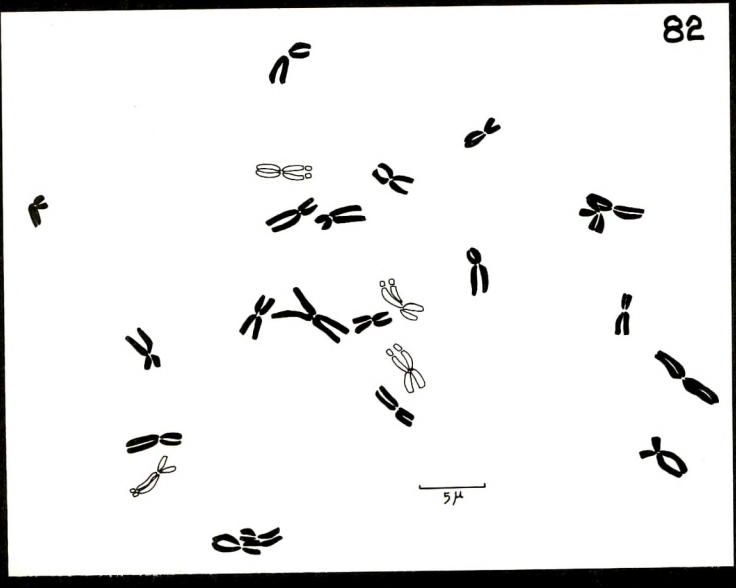


H. panduraeformis Burm. COLL. NO. 3

82



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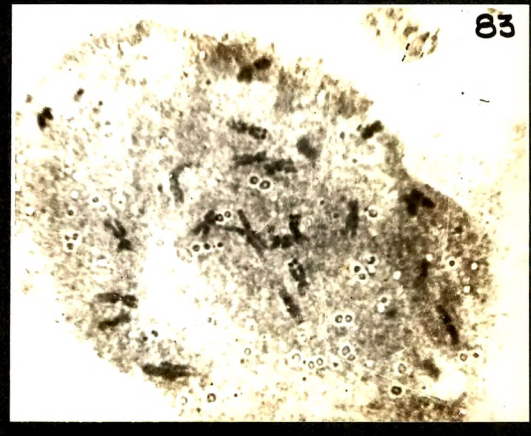

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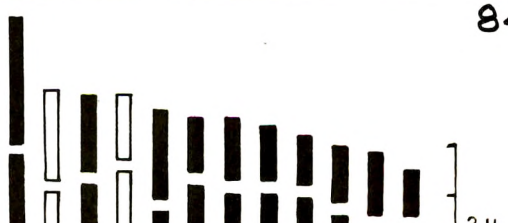

H. panduraeformis Burm. COLL. NO. 26

iii) 3 pairs (E and I -types) are with nearly sub-median centromeres.

iv) Chromosomes are medium to short sized, length ranges from 3.40 μ to 1.82 μ with a mean length of 2.69 μ. TF% being 42.26 shows symmetrical nature, idiogram and relative length reveal the graded nature of the karyotype (Fig. 81).

Coll. No. 26 :

$$2n = 24 = A_2 + C_2 + D_2 + D_2^{S'} + E_8 + E_2^{S'} + G_6$$

Following types of chromosomes are present in the complement (Figs. 82, 83 and 84).

i) 1 pair (C-type) is with median centromere.

ii) Of the 6 pairs (A, D and G -types) with nearly median centromeres, 1 pair ($D^{S'}$-type) has secondary constriction on long arms.

iii) 5 pairs (E-type) are with nearly sub-median centromeres. 1 pair ($E^{S'}$-type) has secondary constriction on long arms.

iv) The chromosomes are long to short sized, length ranges from 5.44 μ to 2.38 μ with a mean length of 3.46 μ.

Karyotype is symmetrical as it has TF% of 40.45. Relative length and idiogram show an abrupt gradation of chromosomes in the karyotype due to the first pair (A-type) of chromosome which is very long when compared to the others (Fig. 84).

Coll. No. 37 :

$2n = 24 = D_{10} + D_2^{S'} + E_2 + G_8 + I_2$.

The somatic complement consists of the following types of chromosomes (Figs. 85, 86 and 87).

i) Of the 10 pairs (D and G -types) with nearly median centromeres, 1 pair ($D^{S'}$-type) is with secondary constriction on long arms.

ii) 2 pairs (E and I -types) are with nearly sub-median centromeres.

iii) Chromosomes are medium to short sized, length ranges from 3.91 μ to 1.70 μ with a mean length of 2.88 μ. TF% being 41.19 reveals symmetrical nature of the karyotype, idiogram and relative length show a graded nature (Fig. 87).

Coll. No. 37 :

Figs. 85 and 86 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 87 - Idiogram.

Meiotic stages

Coll. No. 37 :

Fig. 88 - Diakinesis showing 12 bivalents with 1 bivalent attached to the nucleolus.

Fig. 89 - Anaphase II showing non-synchronized division.

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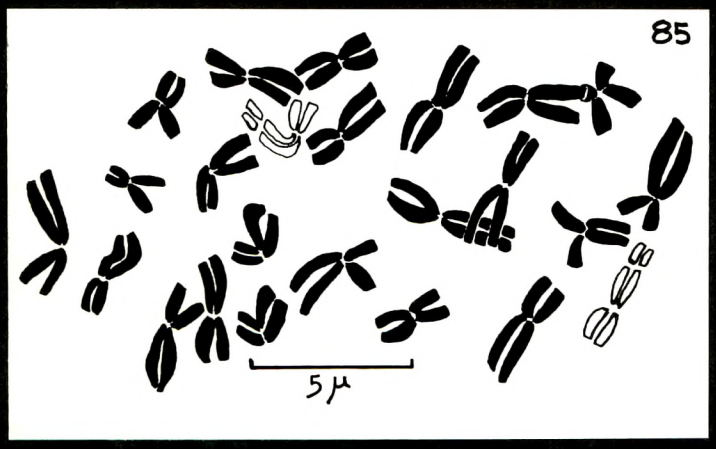
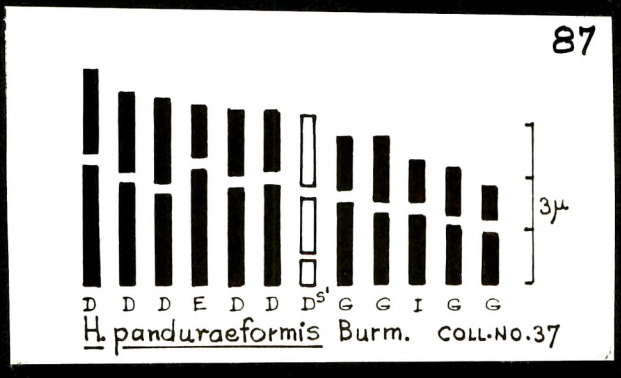
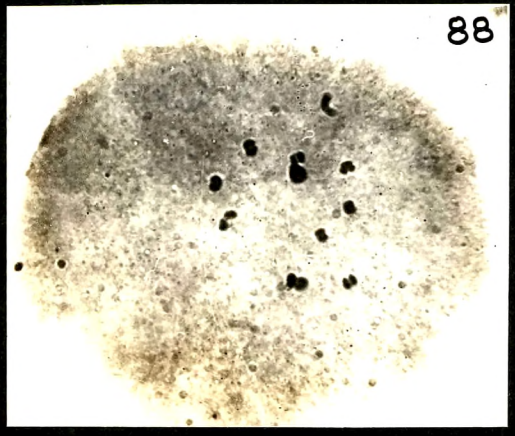

85
5μ


86


87
3μ
D D D E D D D$^{s'}$ G G I G G
H. panduraeformis Burm. COLL.NO.37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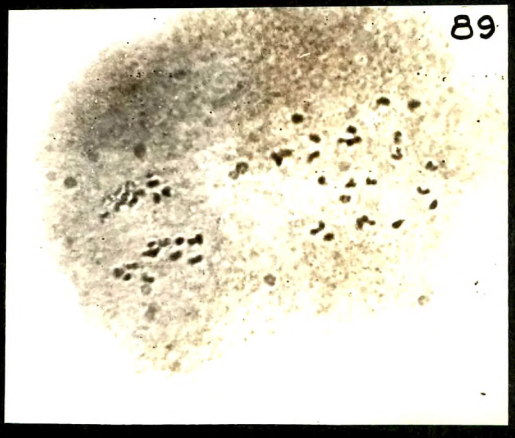

89

Coll. No. 26 :

Fig. 90 - Diakinesis showing 12 bivalents with 2 bivalents near nucleolus.

Fig. 92 - Metaphase I showing secondary association of bivalents in 6 groups

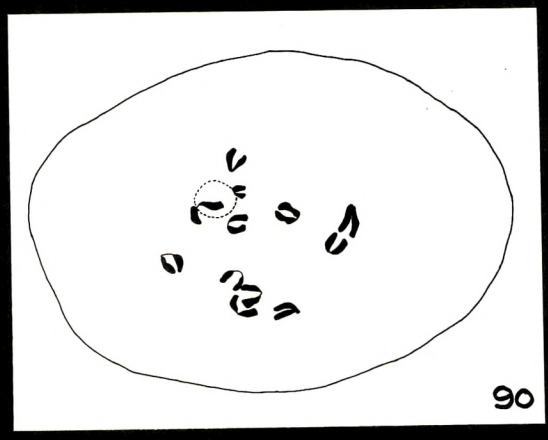
$(1_{(5)} + 2_{(2)} + 3_{(1)})$.

Fig. 93 - Metaphase II.

Fig. 94 - Metaphase II showing grouping of some chromosomes.

Coll. No. 3 :

Fig. 91 - Diakinesis showing 12 bivalents.



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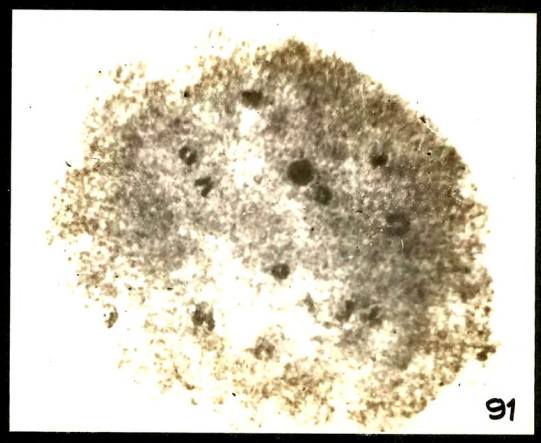

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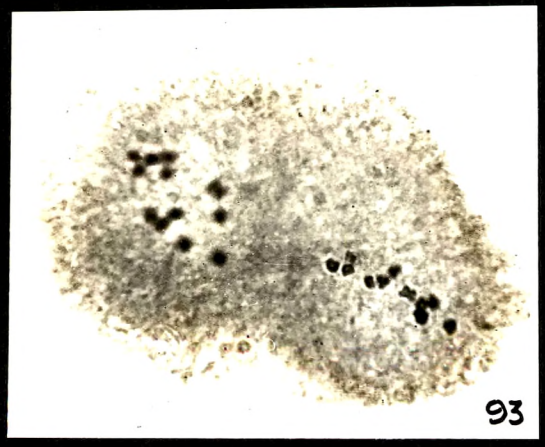

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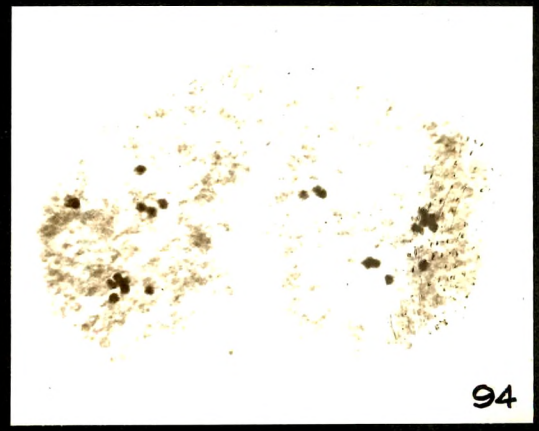


94

Table VI

Comparison of somatic chromosomes of different populations of *H. panduraeformis* Burm.

Populations	Somatic number (2 n)	M		nm			nsm		Sec. consts. on long arm	Range of chromo-some length (in μ)	Absolute length (in μ)
		Types		Types			Types				
		C	F	A	D	G	E	I			
Coll. Nos. 3 and 9	24	-	4	-	4	10	2	4	2	3.40-1.82	64.70
Coll. No. 26	24	2	-	2	4	6	10	-	4	5.44-2.38	82.79
Coll. No. 37	24	-	-	-	12	8	2	2	2	3.91-1.70	69.05

Though all the populations have same chromosome number 2n = 24, they differ among themselves in type, number in each type, and number of chromosomes with secondary constrictions (Table VI). Thus, the detailed karyotypic analysis of 4 populations reveals the existence of 3 cytotypes within the species H. panduraeformis.

This is the first report of the meiotic study for the species. 12 distinct bivalents are seen at diakinesis and metaphase I. 2 bivalents in Coll. No. 26 and 1 bivalent in other collections are found near nucleolus at diakinesis (Figs. 90, 88 and 91), substantiating the observation of secondary constricted chromosomes in somatic metaphase plates. The secondary associations of bivalents showing 6 groups ($1_{(5)} + 2_{(2)} + 3_{(1)}$ Fig. 92) at metaphase I, grouping of chromosomes at metaphase II (Fig. 94) and non-synchromization at anaphase II (Fig. 89) are some of the abnormalities recorded in few PMCs. during meiotic study of different populations. Pollen fertility is determined as 80% to 90%.

1C. H. caesius Garcke

Two collections (Coll. Nos. 43 and 55) are taken for

H. caesius Garcke

Coll. No. 55 :

Figs. 95 and 96 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

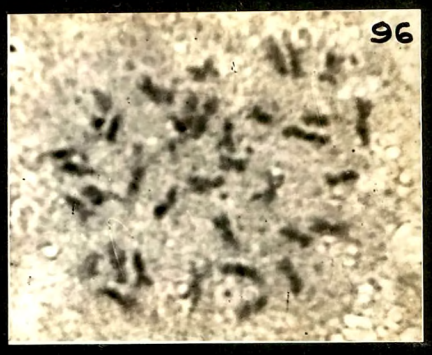
Fig. 97 - Idiogram.

Fig. 98 - Diakinesis showing 18 bivalents with 2 bivalents attached to the nucleolus.

Fig. 99 - Metaphase I (Polar view) showing 18 bivalents.

95

96



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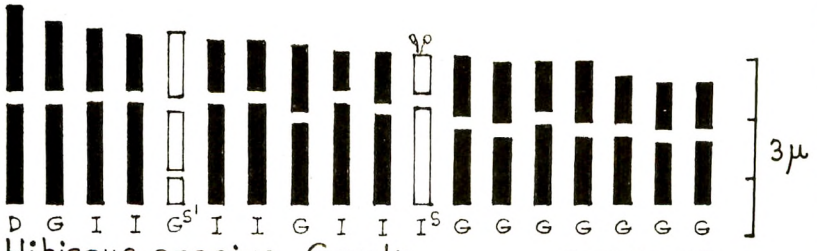
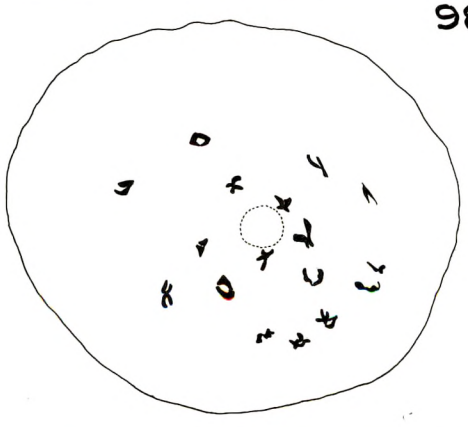


Hibiscus caesius Garcke COLL.NO.55

98



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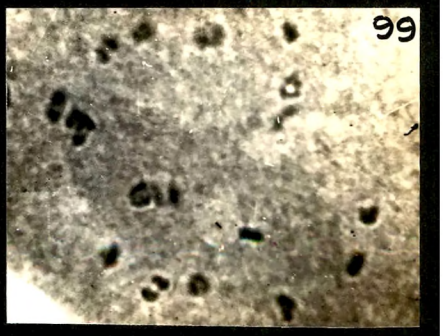


the present investigation. Both of them show similar genomes. No earlier record of the cytological work for the species is mentioned in the available literature. The chromosome number n = 18 and 2n = 36 are therefore, the first reports for the species.

$$2n = 36 = D_2 + G_{18} + G_2^{S'} + I_{12} + I_2^S$$

The complement contains the following types of chromosomes (Figs. 95, 96 and 97).

i) 11 pairs (D and G -types) are with nearly median centromeres, 1 pair ($G^{S'}$-type) of which has secondary constriction on long arms.

ii) Of the 7 pairs (I-type) with nearly sub-median centromeres one pair (I^S-type) has a satellites.

iii) Chromosomes are medium to short sized, range in length from 3.15 μ to 1.87 μ with a mean length of 2.41 μ. TF% being 39.43 shows more or less symmetrical nature of the karyotype. Idiogram and relative length show graded nature of the karyotype (Fig. 97).

The meiosis is regular showing 18 bivalents at diakinesis and metaphase I (Figs. 98 and 99). The 2 bivalents

near the nucleolus in PMCs confirm the presence of one pair of chromosome with satellites and another pair with secondary constrictions in the somatic complement (Fig. 98). Pollen fertility determined as 98%.

Genus - Abelmoschus Medik.

11. A. manihot (Linn.) Medik.

Only chromosome record 2n = 66 by Skovsted (1935 syn. H. manihot) for the species could be traced in the available literature. The detailed cytological study of 1 collection (Coll. No. 8) revealed the chromosome number to be 130 in somatic nucleus and 65 in the generative nucleus.

$$2n = 130 = F_8 + G_{74} + G_4^{S'} + I_{10} + I_2^{S'} + J_8 + K_{14} + L_{10}$$

The somatic complement contains the following types of chromosomes. (Figs. 100, 101 and 102).

i) 8 pairs (F and J -types) are with median centromeres.

ii) Of the 46 pairs (G and K -types) with nearly median centromeres, 2 pairs ($G^{S'}$-type) are with secondary constriction on long arms.

iii) 11 pairs (I and L -types) are with nearly sub-median centromeres. One pair ($I^{S'}$-type) is with secondary constriction on long arms.

Abelmoschus manihot (Linn.) Medic.

Coll. No. 8 :

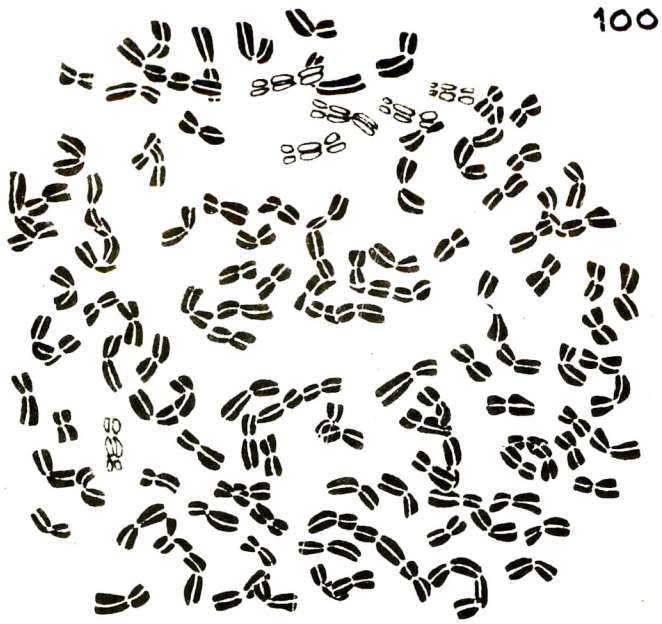
Figs. 100 and 101 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 102 - Idiogram.

Fig. 103 - Metaphase II.

Fig. 104 - Metaphase I showing 65 bivalents.

100



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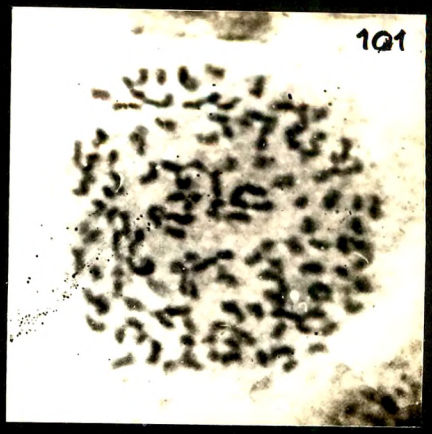
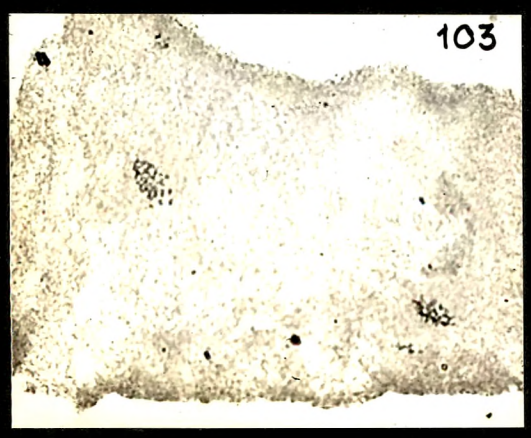


102

Abelmoschus manihot (Linn.) Medic. COLL. NO. 8

103



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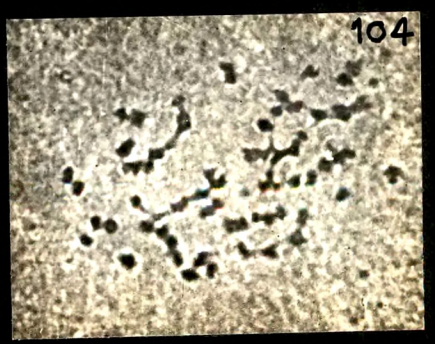


iv) Chromosomes are short to very short sized, ranging in length from 1.79 μ to 0.68 μ with a mean length of 1.33 μ. The karyotype appears more symmetrical with TF% of 42.09. Idiogram and relative length show the graded nature of the karyotype (Fig. 102). Meiosis is regular showing 65 bivalents at metaphase I (Fig. 104). Pollen fertility is 80%.

12. A. angulosus Wight & Arn.

This is the first report of 2n number and karyotype analysis. 130 chromosomes were observed in the somatic complement.

$$2n = 130 = F_{10} + G_{98} + G_2^S + G_2^{S'} + I_{14} + I_2^S + K_2$$

The karyotype shows the following types of chromosomes (Figs. 105, 106 and 107).

i) 5 pairs (F-type) are with median centromeres.

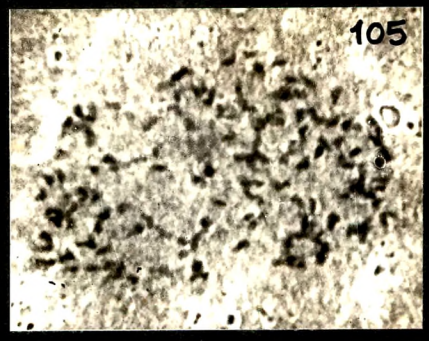
ii) Of the 52 pairs (G and K -types) with nearly median centromeres one pair (G^S-type) is with satellites and another pair ($G^{S'}$-type) is with secondary constrictions.

A. angulosus Wt. & Arn.

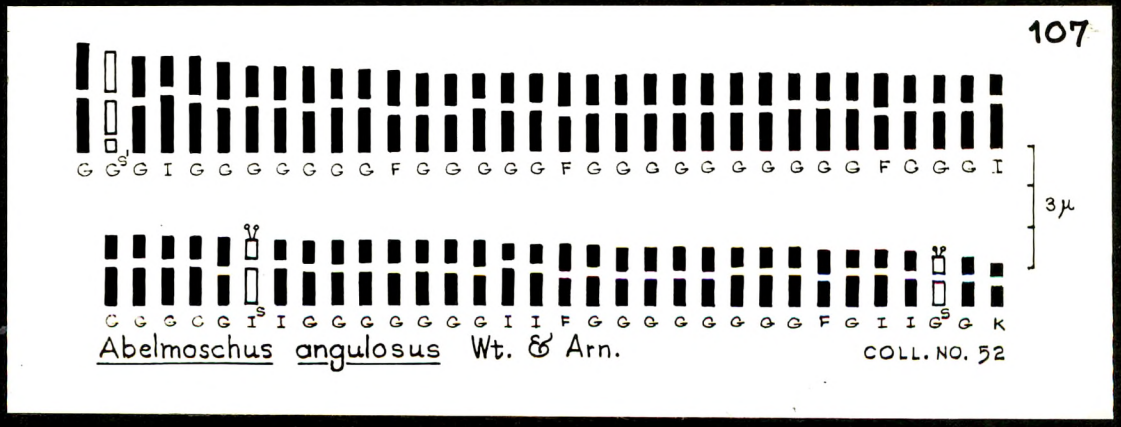
Coll. No. 52 :

Figs. 105 and 106 - Somatic metaphase plate (Photomicrograph and camera lucida drawing).

Fig. 107 - Idiogram.


105


106
5μ


107
3μ
Abelmoschus angulosus Wt. & Arn.
COLL. NO. 52

iii) 8 pairs (I-type) are with nearly sub-median centromeres, one pair of which (I^S-type) is with satellites.

iv) The chromosomes are short to very short sized, ranging in length from 2.55 μ to 0.94 μ with a mean length of 1.60 μ. The TF% is 42.75 showing the symmetrical nature, relative length and idiogram reveal graded nature of the karyotype (Fig. 107).

Genus - Azanza Alef.

13. A. lampas (Cav.) Alef.

As the species growing in different localities showed variations in external morphology, 5 collections (Coll. Nos. 10, 12, 31, 32 and 51) were studied cytologically.

n = 13 and 2n = 26 by Youngman (1931) and n = 13 by Rao (1967, syn. Thespesia lampas) are the chromosome reports that could be traced in the available literature. However, in the present work n = 14 and 2n = 28 are the chromosome numbers recorded for all the collections.

Coll. No. 10 :

$$2n = 28 = G_{14} + I_{12} + I_2^{S'}$$

The complement consists of the following types of chromosomes (Figs. 108, 109 and 110).

Azanza lampas (Cav.) Alef.

Coll. No. 10 :

Figs. 108 and 109 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 110 - Idiogram.

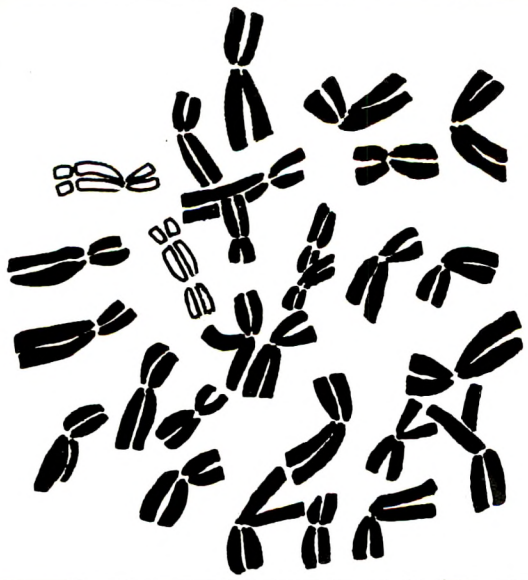
Coll. No. 12 :

Figs. 111 and 112 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 113 - Idiogram.

Contd.....

108



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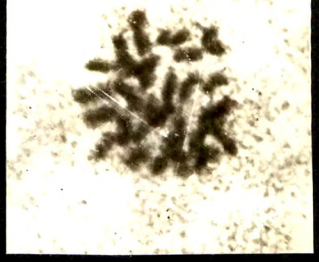
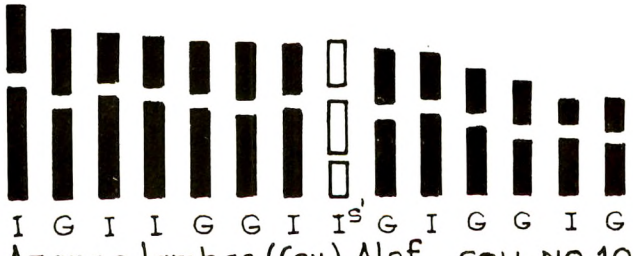
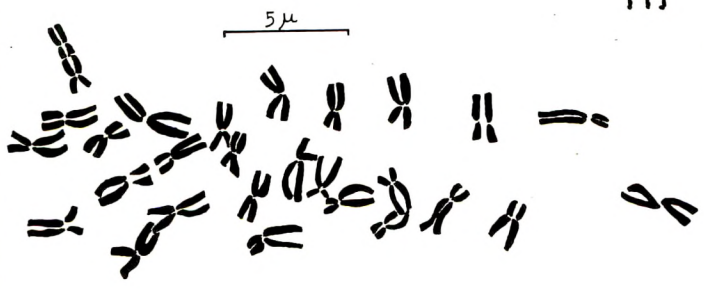


110

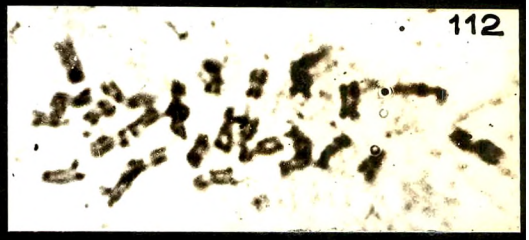


Azanza lampas (Cav.) Alef. COLL.NO.10

111



112



113

Azanza lampas (Cav.) Alef. COLL.NO.12

i) 7 pairs (G-type) are with nearly median centromeres.

ii) Of the 7 pairs (I-type) with nearly sub-median centromeres, 1 pair ($I^{S'}$-type) has secondary constriction on long arms.

iii) The chromosomes are short sized. They range in length from 2.72 μ to 1.28 μ, their mean length being 1.10 μ, with TF% of 37.95, indicates asymmetrical nature of the karyotype.Idiogram and relative length show a graded nature of the karyotype (Fig. 110).

Coll. Nos. 12, 31, and 32.

$2n = 28 = D_2 + F_2 + G_{12} + I_{12}$.

Chromosomes of the somatic complement can be classified into the following morphologically distinguishable types (Figs. 111, 112 and 113).

i) 1 pair (F-type) is with median centromere.

ii) 7 pairs (D and G -types) are with nearly median centromeres.

iii) 6 pairs (I-type) are with nearly sub-median centromeres.

iv) The chromosomes are medium to short sized, ranging in length from 3.06 μ to 1.45 μ with a mean length of 2.13 μ. TF% being 38.74, shows the tendency of the karyotype towards asymmetrical nature. Relative length and idiogram show a graded nature of the karyotype (Fig. 113).

Coll. No. 51.

$2n = 28 = F_2 + G_{18} + I_8$.

The complement contains the following types of chromosomes (Figs. 114, 115 and 116).

i) 1 pair (F-type) is with median centromere.

ii) 9 pairs (G-type) are with nearly median centromeres.

iii) 4 pairs (I-type) are with nearly sub-median centromeres.

iv) Chromosomes are short in size, ranging in length from 2.98 μ to 1.28 μ with a mean length of 2.14 μ. TF% being 40.40 shows more or less symmetrical nature of the karyotype. Relative length and idiogram show a graded nature of the karyotype (Fig. 116). All the 5 populations resemble each other in total chromatin

Coll. No. 51 :

Figs. 114 and 115 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 116 - Idiogram.

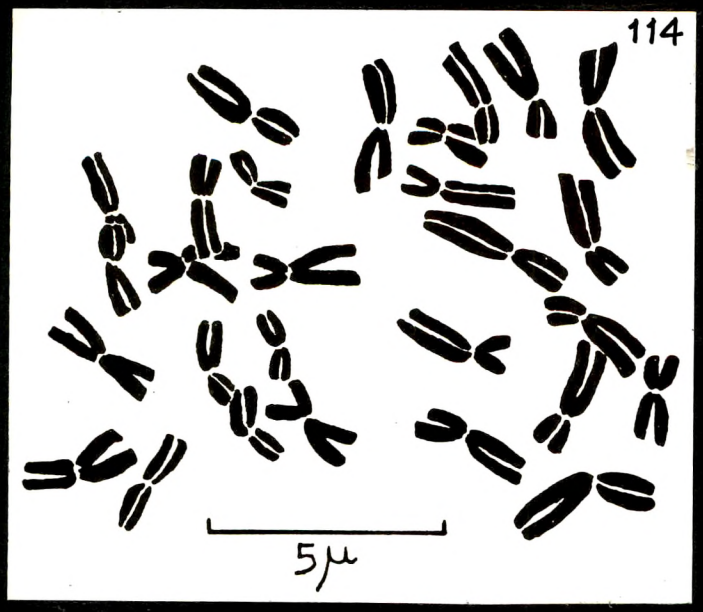
Meiotic stages

Coll. No. 10 :

Figs. 117 and 118 - Metaphase I (side view) showing 14 bivalents (camera lucida drawing and photomicrograph).

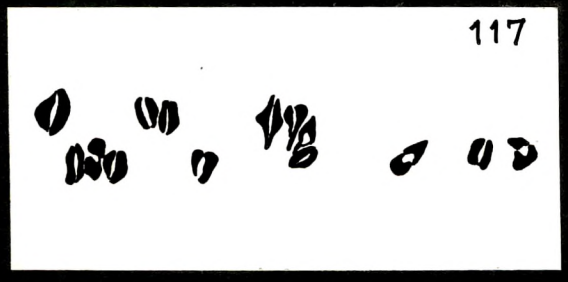
Coll. No. 12 :

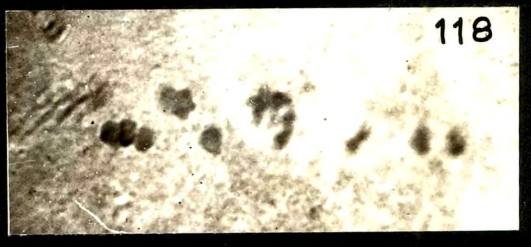
Fig. 119 - Anaphase I.


114
5μ


115


116
3μ
G G G I I I F I G G G G G G
Azanza lampas (Cav.) Alef. COLL. NO. 51


117


118

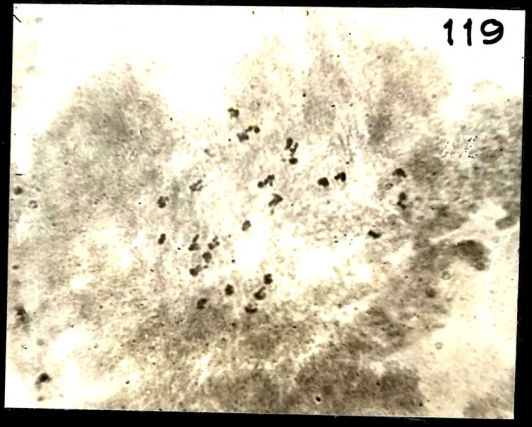

119

Table VII

Comparison of the somatic chromosomes of the different populations of A. lampas (Cav.)Alef.

Populations	Somatic number (2n)	M	nm		nsm	Sec. consts. on long arm	Range of Chromosome length (in μ)	Absolute length (in μ)
		Type	Types		Types			
		F	D	G	I			
Coll. No. 10	28	-	-	14	14	2	2.72-1.28	55.86
Coll. Nos. 12, 31 and 32	28	2	2	12	12	-	3.06-1.45	59.47
Coll. No. 51	28	2	-	18	8	-	2.98-1.28	59.75

length, range of chromosome length and in somatic chromosome number as 2n = 28. They differ from each other in having different numbers of chromosomes with median, nearly median and nearly sub-median centromeres (Table VII). But for Coll. No. 10, in all other collections satellited or secondarily constricted chromosomes are not noticed.

Polygraphic and karyotypic studies of the populations reveal the presence of 3 ecotypes. Coll. Nos. 12, 31 and 32 represent the first; Coll. No. 51 the second and Coll. No. 10 the third ecotype, present within the species Azanza lampas.

The meiotic behaviour is regular in all the populations. In contrast to Youngman's (1931) and Rao's (1967) reports of n = 13, the present observation is n = 14 at metaphase I (Figs. 117 and 118) and anaphase I (Fig. 119). The pollen fertility ranging from 85% to 95% in all collections shows the regular pollen formation.

Genus - Thespesia Soland. ex Corr.

14. T. populnea (Linn.) Soland. ex Corr.

Detailed analysis of the karyotypes of two populations (Coll. Nos. 49 and 50) was carried out. Earlier reports are

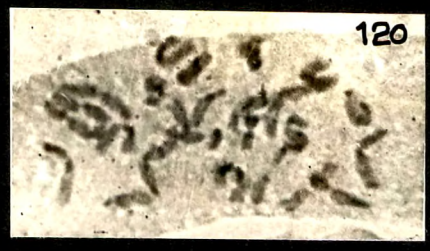
Thespesia populnea Soland.

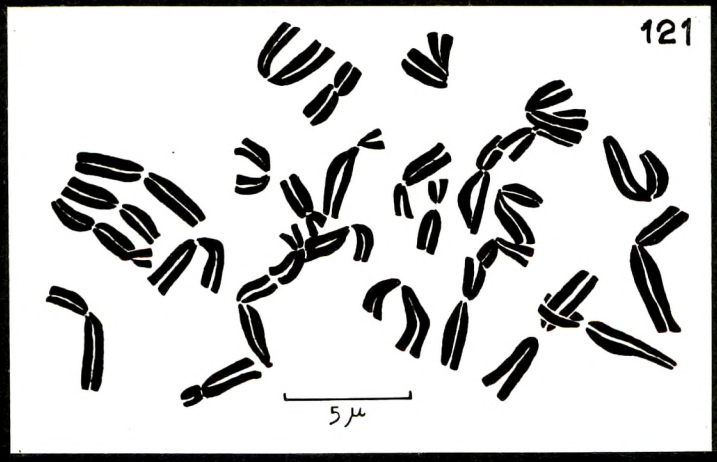
Coll. No. 49 :

Figs. 120 and 121 - Somatic metaphase plate (Photomicrograph and camera lucida drawing).

Fig. 122 - Idiogram.

Contd.....


120


121
5μ


122
3μ
B A B B D E D D D D E G G I
Thespesia populnea Soland. COLL.NO. 49

n = 13 and 2n = 26 by Youngman (1931); n = 12 and 2n = 24 by Hazra and Sharma (1971). In contrast to these findings the present observations are n = 14 and 2n = 28 for the species.

$$2n = 28 = A_2 + B_6 + D_{10} + E_4 + G_4 + I_2.$$

The chromosome types observed in the somatic complement are as follows (Figs. 120, 121 and 122).

i) 8 pairs (A, D and G -types) are with nearly median centromeres.

ii) 6 pairs (B, E and I -types) are with nearly sub-median centromeres.

iii) Within the complement, 8 chromosomes are long, 14 chromosomes are medium and 6 chromosomes are short in length. They range from 6.04 μ to 2.55 μ with a mean length of 4.33 μ. Idiogram and relative length show more or less graded nature of the karyotype. Last 3 pairs (2 G and 1 I-types) are little abruptly graded (Fig. 122). More or less symmetrical nature of the karyotype is indicated by TF% as 39.54.

Hazra and Sharma (1971) have reported 1 pair of

Fig. 123 - Metaphase I (Polar view) showing grouping of some bivalents.

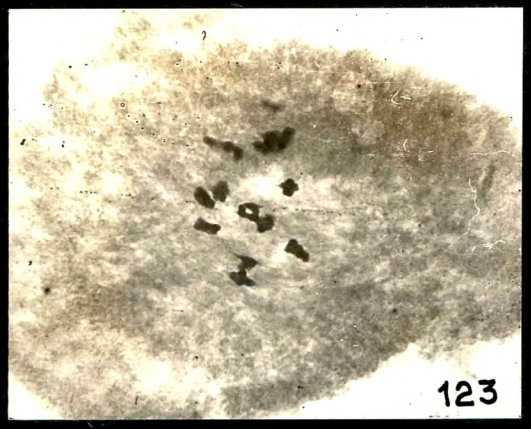
Fig. 124 - Metaphase I (Side view) showing 14 bivalents.

Fig. 125 - Metaphase I showing non-congressional bivalent (↑).

Fig. 126 - Metaphase I (side view) showing interlocking of 2 bivalents (↑).

Fig. 127 - Metaphase I showing non-congressional bivalents (↑).

Fig. 128 - Anaphase I.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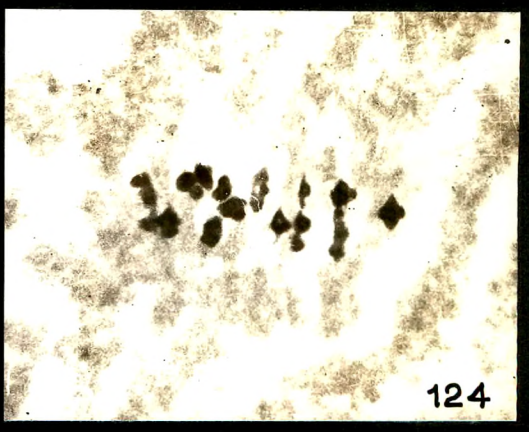
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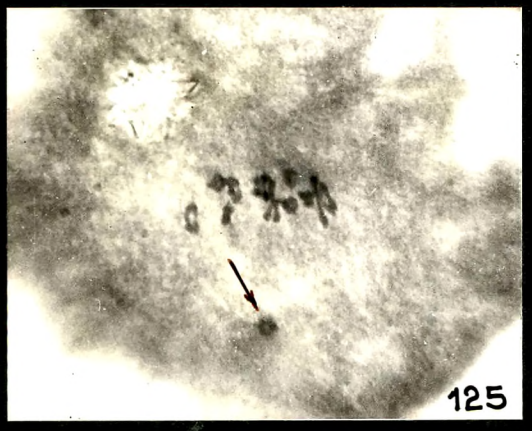
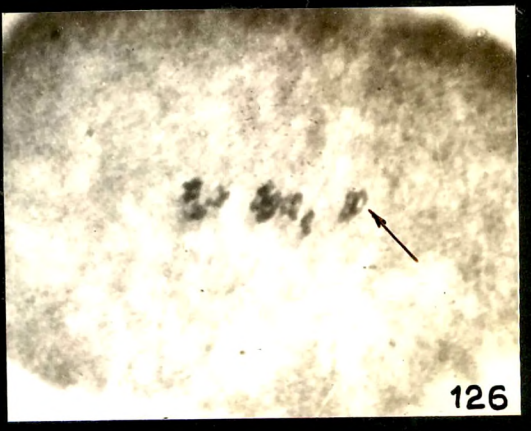

125


126


127


128

Malachra capitata Linn.

Coll. No. 36 :

Fig. 129 and 130 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 131 - Idiogram.

Figs. 132 and 133 - Metaphase I showing 28 bivalents (camera lucida drawing and photomicrograph).

Fig. 134 - Anaphase I.

chromosomes with secondary constriction in var. I and 2 pairs in var. II. In Youngman's work (1931) as well as in the present work, chromosomes with secondary constriction are not noticed.

Meiosis is fairly regular showing 14 bivalents at metaphase I and anaphase I (Figs. 124, 128). Abnormalities like non-congressional (Figs. 125 and 127) interlocking (Fig. 126) and tendency towards association of bivalents (Fig. 123) are observed in few PMCs. Pollen fertility is about 80%.

Tribe - Ureneae

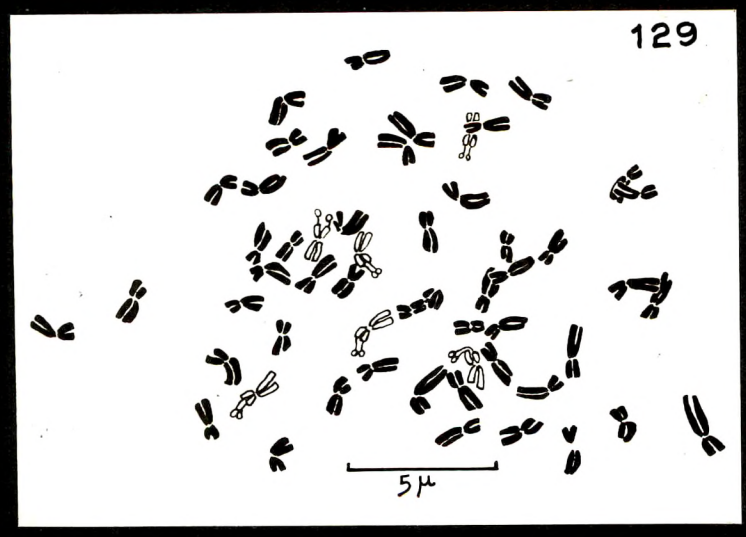
Genus - Malachra Linn.

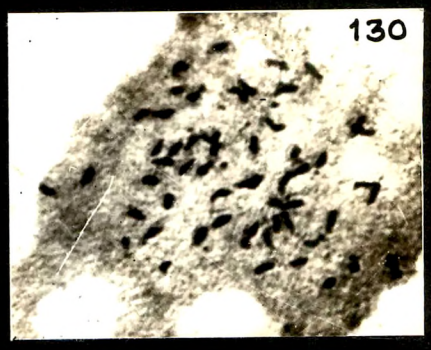
15. M. capitata Linn.

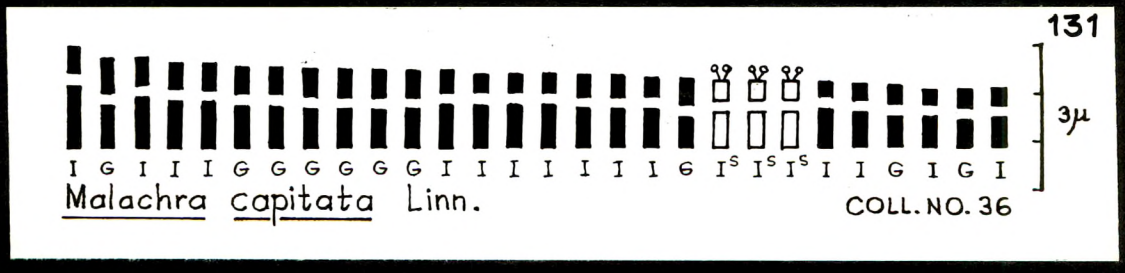
Two populations (Coll. Nos. 36 and 38) were scrutinized in the present study. They show similar karyomorphology. The present report of 2n = 56 is in line with the previous reports by Skovsted (1935), and Hazra and Sharma (1971). However, n = 28, is reported for the first time.

$$2n = 56 = G_{20} + I_{30} + I_6^S .$$

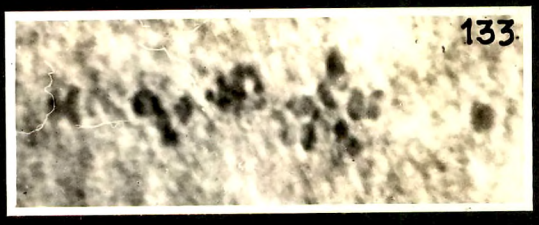
Karyotype analysis of the somatic complement show the

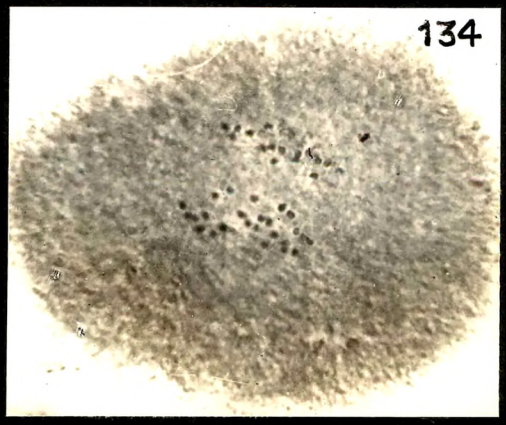

129
5μ


130


131
3μ
I G I I I G G G G G G I I I I I I I G I^S I^S I^S I I I G I G I
Malachra capitata Linn.
COLL. NO. 36


132


133


134

following details (Figs. 129, 130 and 131).

i) 10 pairs (G-type) are with nearly median centromeres.

ii) 18 pairs (I-type) are with nearly sub-median centromeres, of which 3 pairs (I^S-type) are with satellites.

iii) Chromosomes are short sized, length ranges from 1.96 μ to 1.02 μ with a mean length of 1.37 μ. Idiogram and relative length reveal that the karyotype is of graded nature (Fig. 131). TF% is 36.89 indicating asymmetrical nature of the complement.

Skovsted (1935) has reported two pairs of chromosomes with satellites. Hazra and Sharma (1971) have reported 2 pairs of secondarily constricted and 1 pair of satellited chromosomes in the taxa they have analysed. The present investigation of 2 populations show 3 pairs of satellited chromosomes in the somatic complement.

Meiosis is regular. PMCs show 28 bivalents at metaphase I (Figs. 132 and 133) and regular distribution at anaphase I (Fig. 134). 80% pollens are fertile.

Genus - Urena Linn.

16. U. lobata Linn.

As the species exhibits a great variability in the morphological characters, 4 populations collected from different areas were taken for cytological investigation.

The chromosome numbers n = 14 and 2n = 28 are in confirmity with the previous reports by Skovsted (1941); Hazra and Sharma (1971). However, 2n = 56 has also been recorded by Skovsted (1941) and Kootin-sanwu (1969).

Coll. No. 29 :

$2n = 28 = G_{16} + G_2^S + G_2^{S''} + I_8$.

The complement consists of the following types of chromosomes (Figs. 135 and 136).

i) 10 pairs (G-type) are with nearly median centromeres. One pair of which (G^S-type) has satellites and another pair ($G^{S''}$-type) has secondary constrictions on short arms.

ii) 4 pairs (I-type) are with nearly sub-median centromeres.

iii) Two darkly stained bodies (probably β-chromosomes)

Urena lobata Linn.

Coll. No. 29 :

Fig. 135 - Somatic metaphase plate with 2 β- chromosomes (↑).

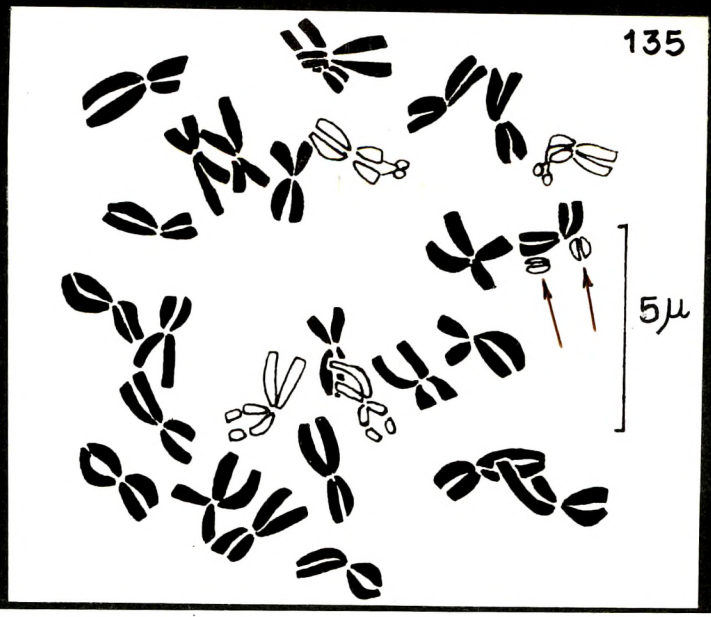
Fig. 136 - Idiogram.

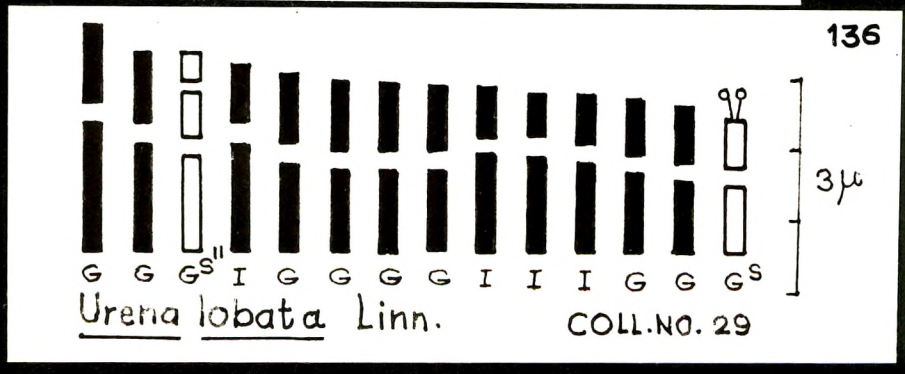
Coll. No. 41 :

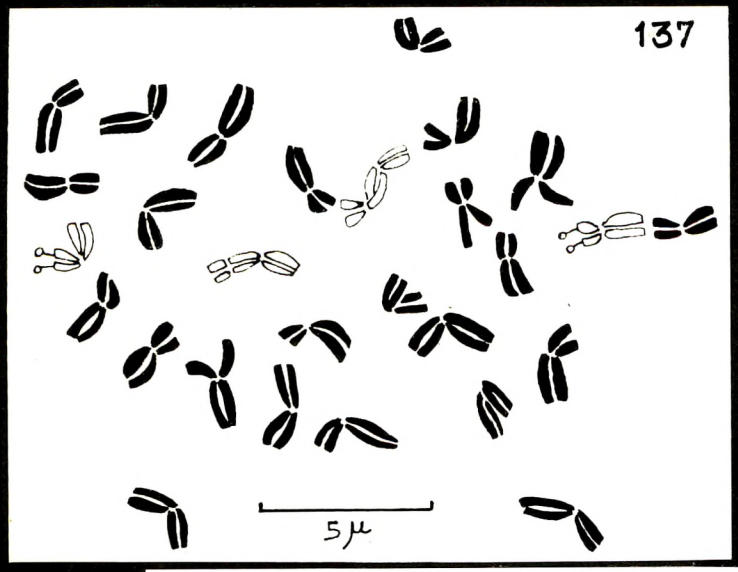
Figs. 137 and 138 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

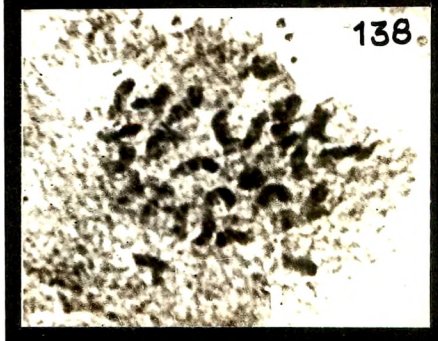
Fig. 139 - Idiogram.

Contd.....


135
5μ


136
3μ
G G G^SII I G G G G I I I G G G^S
Urena lobata Linn. COLL.NO. 29


137
5μ


138


139
3μ
G G G G^S' G G I G I G I G I^S I
Urena lobata Linn. COLL.NO. 41

are present in the complement.

iv) Chromosomes are short sized, length ranges from 2.98 μ to 1.62 μ with a mean length of 2.20 μ. As TF% is 41.05, the karyotype appears quite symmetrical. Relative length and idiogram show a graded nature of the karyotype (Fig. 136).

Coll. No. 41 :

$2n = 28 = G_{16} + G_2^{S'} + I_8 + I_2^{S}$.

The complement consists of the following types of chromosomes (Figs. 137, 138 and 139).

i) 9 pairs (G-type) are with nearly median centromeres, out of which 1 pair ($G^{S'}$-type) has secondary constriction on long arms.

ii) Of the 5 pairs (I-type) with nearly sub-median centromeres, 1 pair (I^{S}-type) is with satellites.

iii) Chromosomes are short sized, length ranges from 2.99 μ to 1.87 μ with a mean length of 2.37 μ. TF% being 40.81 shows symmetrical nature, idiogram and relative length show a graded nature of the karyotype (Fig. 139).

Table VIII

Comparison of the somatic chromosomes of the different populations of U. lobata Linn.

Populations	Somatic number (2 n)	nm	nsm	Sec. consts. on		SATs	Range of Chromo-some length (in μ)	Absolute length (in μ)
		Type G	Type I	long arm	short arm			
Coll. No. 29	28	20	8	-	2	2	2.98-1.62	61.71
Coll. No. 41	28	18	10	2	-	2	2.99-1.87	66.27
Coll. Nos. 27 and 48	28	16	12	2	-	2	2.13-1.28	46.58

Coll. Nos. 27 and 48 :

$2n = 28 = G_{12} + G_2^S + G_2^{S'} + I_{12}$.

The following types of chromosomes are present in the somatic complement (Figs. 140, 141 and 142).

i) 8 pairs (G-type) are with nearly median centromeres. 1 pair (G^S-type) is with satellites and another pair ($G^{S'}$-type) has secondary constriction on long arms.

ii) 6 pairs (I-type) are with nearly sub-median centromeres.

iii) The chromosomes are of short size, length ranges from 2.13 μ to 1.28 μ with a mean length of 1.66 μ. TF% being 38.68 indicates a slight asymmetrical nature, idiogram and relative length show a graded nature of the karyotype (Fig. 142).

Different populations have the same chromosome number (i.e. 2n = 28) and the karyotypes show a gross resemblance among themselves. The karyotypes of collection numbers 27 and 48 resemble each other in all respects, but differ from other two collections (i.e. 29 and 41). The collection numbers 29 and 41 show differences among themselves in the position of the secondary constriction and number of chromosomes in each type within their complements (Table VIII).

Coll. No. 48 :

Figs. 140 and 141 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 142 - Idiogram.

Meiotic stages

Coll. No. 29 :

Fig. 143 - Diakinesis with 2 nucleolus and 2 β-chromosomes (↑).

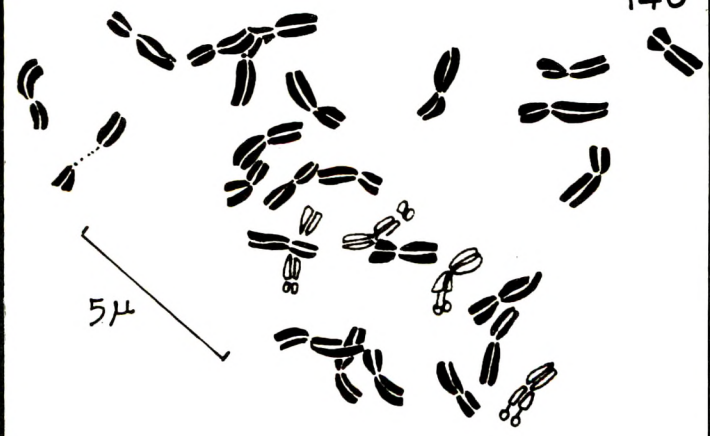
Coll. No. 41 :

Fig. 144 - Metaphase I showing 28 bivalents.

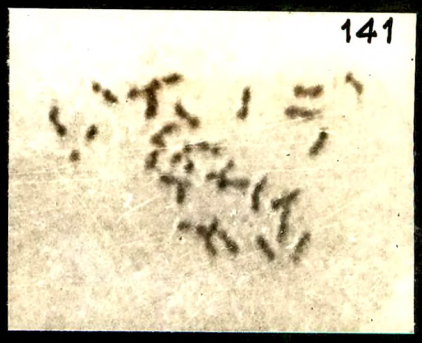
Fig. 145 - Metaphase I showing 7 groups of bivalents ($2_{(3)} + 3_{(2)} + 2_{(1)}$).

Fig. 146 - Anaphase I.

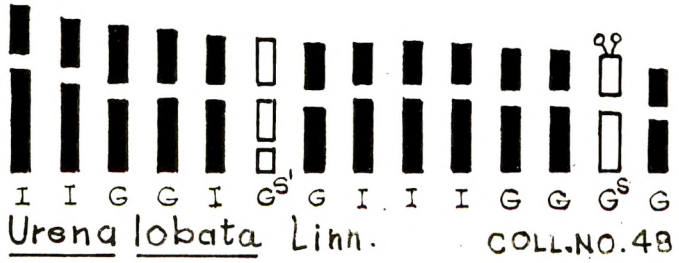
140



141

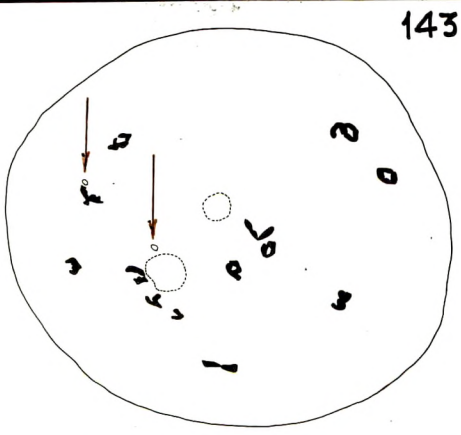


142

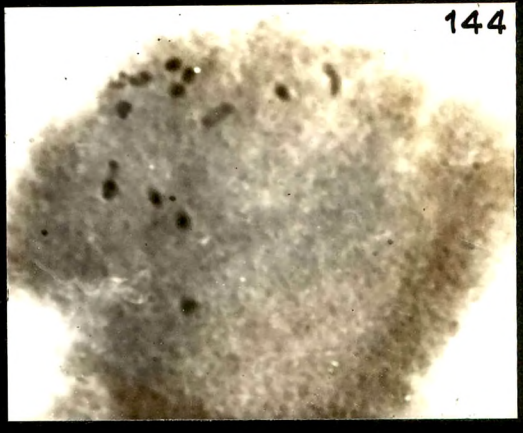


Urena lobata Linn. COLL.NO.48

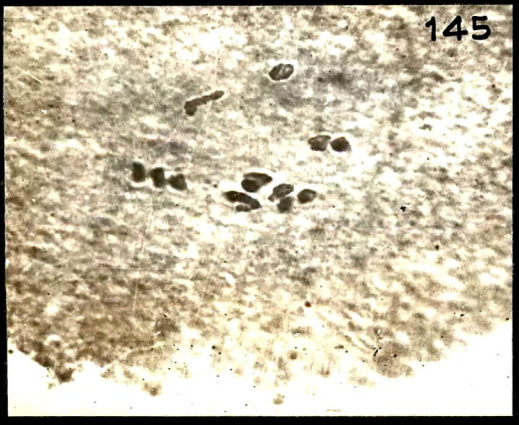
143



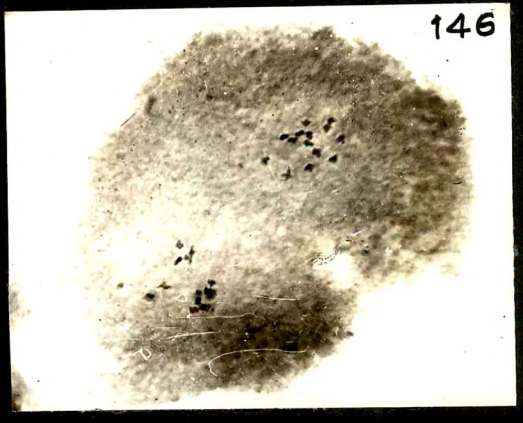
144



145



146



The karyomorphological study of these populations, does not tally with the findings of polygraphic study in all respects, for Coll. Nos. 29 and 41 included in one group under U. sinuata (polygraphic study) show some minor karyotypic differences. However, the presence of 2 distinct species is indicated by karyomorphological studies.

Hazra and Sharma (1971) have reported the presence of 1 pair of SAT-chromosome and 3 pairs of secondarily constricted chromosomes in the taxon they analysed. All the 4 populations studied presently showed the presence of a pair of SAT-chromosomes and a pair of secondarily constricted chromosomes.

The present report of n = 14 is in line with the previous report by Hazra and Sharma (1971). In addition to normal bivalents (n = 14), two darkly stained bodies, were observed at diakinesis in Coll. No. 29 (Fig. 143). This confirms the early report of the same by Hazra and Sharma (1971). The meiosis is fairly regular in the majority of the populations studied (Figs. 144 and 146). However, grouping of bivalents at metaphase I ($2_{(3)} + 3_{(2)} + 2_{(1)}$ = 7 groups) is noticed in a few PMCs of Coll. No. 41 (Fig. 145). Pollen fertility determined is 80% to 85% in all the populations.

Genus - Pavonia Cav.

17. P. zeylanica Cav.

It is apparent from the available literature that the species has remained unexplored cytologically. The karyotypes of the 2 populations (Coll. Nos. 40 and 56) studied presently, resemble each other. The n and 2n numbers recorded are 28 and 56 respectively.

$$2n = 56 = D_8 + E_2 + G_{28} + G^S_2 + I_{16}.$$

The following morphologically distinguishable types of chromosomes are present in their somatic complements (Figs. 147, 148 and 149).

i) Amongst 19 pairs (D and G -types) with nearly median centromeres, 1 pair (G^S-type) is with satellites.

ii) 9 pairs (E and I -types) are with nearly sub-median centromeres.

iii) Chromosomes are of medium to short size, ranging from 3.40 μ to 1.79 μ with a mean length of 2.56 μ. TF% being 39.38 shows more or less symmetrical nature of the karyotype. Relative length and idiogram reveal a

Pavonia zeylanica Cav.

Coll. No. 40 :

Figs. 147 and 148 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 149 - Idiogram.

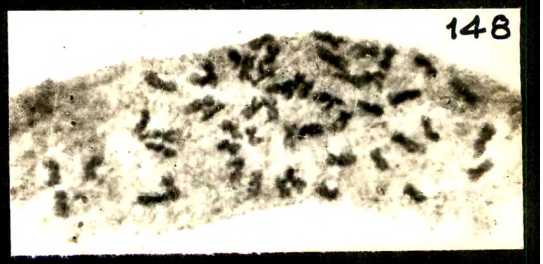
Fig. 150 - Metaphase I (Polar view) showing 28 bivalents.

Fig. 151 - Metaphase I (side view) showing non-congressional bivalent (↑).

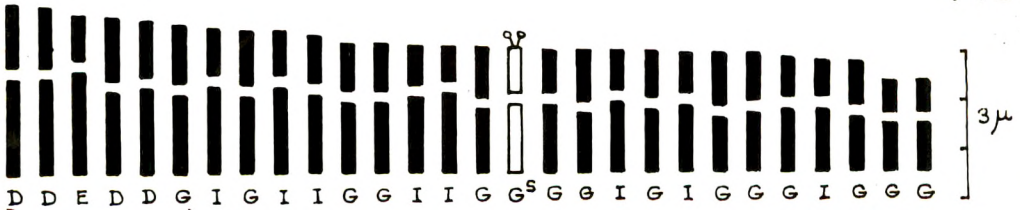
Fig. 152 - Metaphase II.

147

148



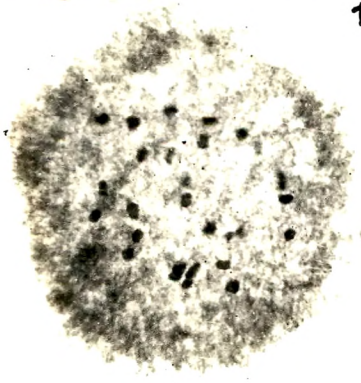
149



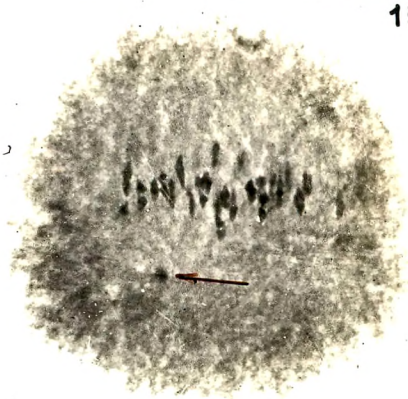
D D E D D G I G I I G G I I G G^{s} G G I G I G G G I G G G

Pavonia zeylanica Cav. COLL. NO. 40

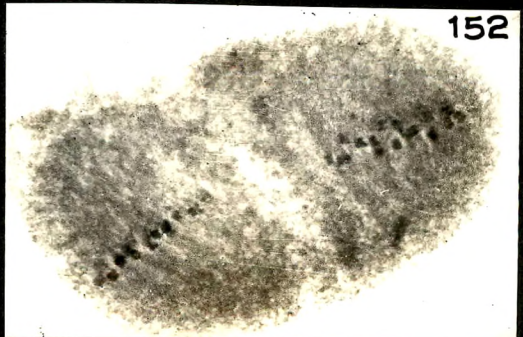
150



151



152



graded nature of the karyotype (Fig. 149).

Number of PMCs examined in both the populations, show normal behaviour of chromosomes with n = 28 at metaphase I and II (Figs. 150 and 152). However, non-congressional bivalent was observed in metaphase I (Fig. 151). Pollen fertility determined as 95%.

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In the present work n = 14 and 2n = 28 are the chromosome numbers recorded for the species which confirms the earlier report of n = 14 by Bates (1967).

$$2n = 28 = D_2 + G_{22} + G_2^S + I_2$$

The somatic complement consists of the following types of chromosomes (Figs. 153, 154 and 155).

i) 13 pairs (D and G -types) are with nearly median centromeres. 1 pair (G^S-type) is with satellites.

ii) Only 1 pair (I-type) is with nearly sub-median centromere.

iii) 1 pair of medium and 13 pairs of short chromosomes are present in the complement. They range from

P. patens (Andr.) Chiov.

Coll. No. 16 :

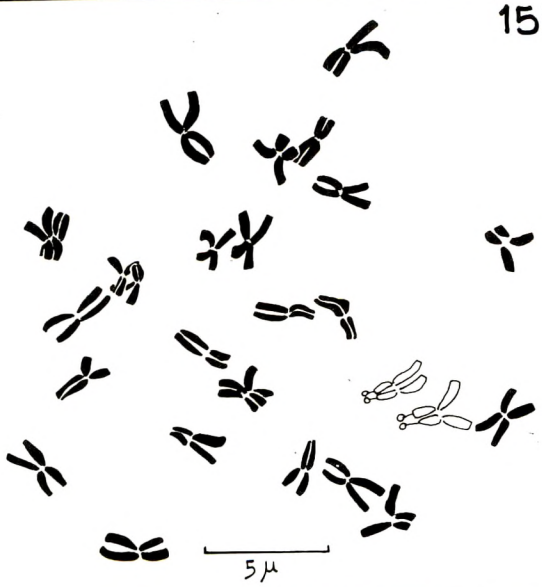
Figs. 153 and 154 - Somatic metaphase plate (camera lucida drawing and photomicrograph).

Fig. 155 - Idiogram.

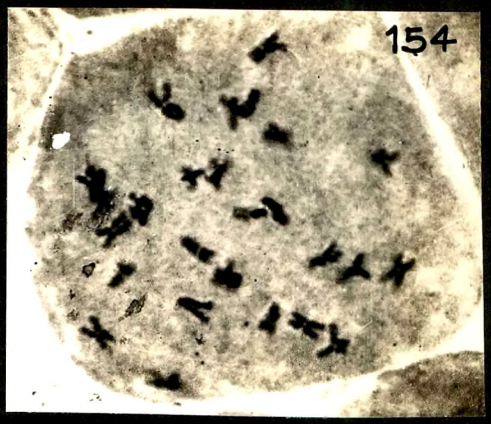
Fig. 156 - Metaphase I showing 2 groups of bivalents.

Fig. 157 - Metaphase I (Polar view) showing 14 bivalents.

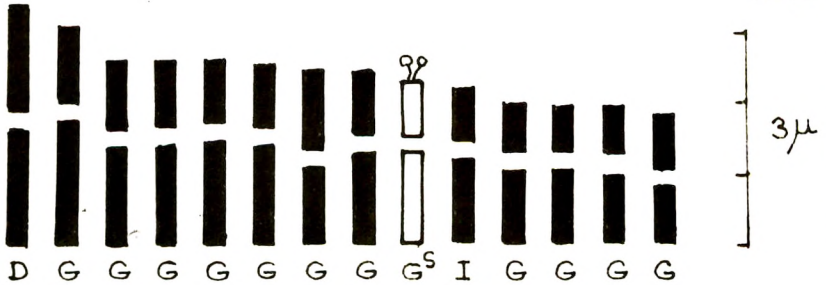
153



154

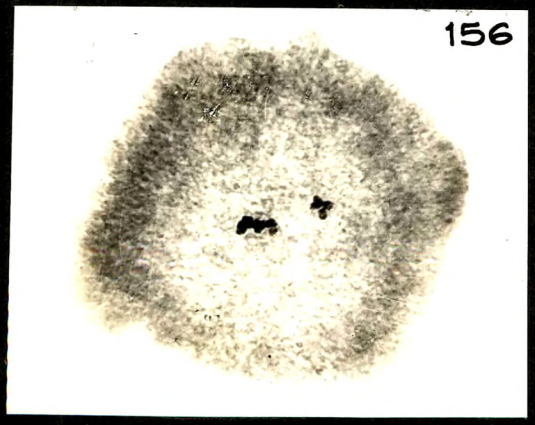


155



Pavonia patens (Andr.) Chiov. COLL.NO.16

156



157

3.23 μ to 1.62 μ with a mean length of 2.27 μ. TF% (41.44), relative length and idiogram show a quite symmetrical and graded nature of the karyotype (Fig. 155).

The meiotic study shows the presence of 14 bivalents at metaphase I (Fig. 157). Except for occasional grouping of bivalents at metaphase I (Fig. 156), meiosis is normal and pollen fertility is 84.11%.

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